DEPARTMENT OF ENERGY OVERSIGHT: STATUS OF CLEAN COAL PROGRAMS

HEARING

BEFORE THE

SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS

OF THE

COMMITTEE ON ENERGY AND COMMERCE

HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRTEENTH CONGRESS

SECOND SESSION

FEBRUARY 11, 2014

Serial No. 113–118

Printed for the use of the Committee on Energy and Commerce
energycommerce.house.gov

U.S. GOVERNMENT PRINTING OFFICE
88–659 WASHINGTON : 2014

For sale by the Superintendent of Documents, U.S. Government Printing Office
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DEPARTMENT OF ENERGY OVERSIGHT: STATUS OF CLEAN COAL PROGRAMS

TUESDAY, FEBRUARY 11, 2014

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS,
COMMITTEE ON ENERGY AND COMMERCE,
Washington, DC.

The subcommittee met, pursuant to call, at 10:04 a.m., in room 2123 of the Rayburn House Office Building, Hon. Tim Murphy (chairman of the subcommittee) presiding.

Members present: Representatives Murphy, Burgess, Gingrey, Scalise, Harper, Olson, Gardner, Griffith, Johnson, Long, Ellmers, Barton, Schakowsky, Butterfield, Castor, Tonko, and Waxman (ex officio).

Staff present: Charlotte Baker, Press Secretary; Karen Christian, Chief Counsel, Oversight; Carrie-Lee Early, Detailee, Oversight; Brad Grantz, Policy Coordinator, Oversight and Investigations; Brittany Havens, Legislative Clerk; Mary Neumayr, Senior Energy Counsel; Sam Spector, Counsel, Oversight; Peter Spencer, Professional Staff Member, Oversight; Tom Wilbur, Digital Media Advisor; Phil Barnett, Staff Director; Brian Cohen, Staff Director, Oversight and Investigations, and Senior Policy Advisor; Kiren Gopal, Counsel; Hannah Green, Staff Assistant; Bruce Ho, Counsel; Elizabeth Letter, Press Secretary; and Alexandra Teitz, Senior Counsel, Environment and Economy.

OPENING STATEMENT OF HON. TIM MURPHY, A REPRESENTATIVE IN CONGRESS FROM THE COMMONWEALTH OF PENNSYLVANIA

Mr. MURPHY. Good morning. Welcome to a hearing of the Energy and Commerce Committee, subcommittee on Oversight and Investigations, this hearing on Department of Energy Oversight, Status of Clean Coal Programs. Today's hearing will review the status of these programs. This oversight, we have focused on the department's efforts to advance carbon capture and sequestration or CCS technologies at coal-based power plants.

Legislation and regulation in this important area should and must be based on sound scientific and economic facts. Where are we? Where are we going? When can we get there? And how do we do it?

Today's testimony, which builds on our oversight work from this past October when we heard from workers and local officials whose coal-dependent communities are suffering in part because of EPA

policies will help us review exactly where DOE is today in its work on CCS.

There are many questions about the current status of this technology. We are sure our panelists today will be able to shed some light on this. Answering these questions and gathering the underlying facts will help us understand how carbon capture technologies can work effectively and reliably on coal-powered plants. This testimony will also help the committee develop a clear and accurate record of what will be necessary, the innovation and operational experience, economics, the timeframes to develop commercially competitive CCS for coal-based power generation.

The technical and economic issues DOE confronts are not everything that is needed to determine if CCS can work at a large level in our nation's electricity system. There are legal issues, regulatory issues, infrastructure issues. All must be addressed appropriately.

Yet when looking at just the critical technical challenges to CCS or coal plants, challenges for which Congress has appropriated billions of dollars to DOE to address, we have a way to go on several levels.

First, it has not yet been demonstrated that CCS systems will work reliably at full-scale coal power plants. It is not sufficient to rely upon paper estimates and laboratories or speculation from EPA lawyers about technological feasibility. Carbon dioxide capture and compression systems have to be integrated into actual, full-scale coal power plants and be shown to operate reliably over time while maintaining predictable and safe plant operations. It does not appear DOE will have complete answers about this for at least 6 to 10 years, so we need an update.

Second, the costs to produce electricity have come down by a large amount to make any successful demonstrated CCS systems commercially viable in open markets. The first generation CCS technology, because of increased capital and operating costs and decreased electricity produced, the electric grid has been estimated to increase the cost of electricity significantly.

At a coal gasification facility, the cost of electricity may be increased by 40 percent, at a pulverized coal power plant by upwards of 80 percent. This is what DOE's own document tells us. Demonstrating full scale CCS is alone not sufficient to make it the standard for the nation's coal-based electricity generation.

If coal power plants cost too much, nobody will build them. Energy costs will increase making it even more difficult for families and U.S. manufacturers to compete.

Which brings me to the third point, the research development and innovative breakthroughs needed to produce economically viable CCS technologies for coal power will take operational experience and time, decades in fact. This is not my opinion. DOE's own R&D timetables make this point to us.

Over the past 10 fiscal years, more than $7.6 billion have been appropriated to DOE for its clean coal programs. This spending reflects the confidence Congress has placed in DOE and the National Energy Technology Laboratory, or NETL, to help advance these technologies.

Given the spending and given the current economic and regulatory landscape, oversight is necessary to ensure DOE's stewardship of these funds and goals for its research are effective.

It is also necessary to make sure energy and environmental policies match the technological realities. We are all committed to clean air, period. But moreover, we must be committed to using North American energy resources rather than continuing our trillion dollar trade deficit with OPEC or $4 trillion wars in the Mideast where we have to defend their oil fields.

In this hearing, I hope we will get some straight answers so that we can establish what is truly the status and prospects of DOE's game plan for advancing coal power technologies. Our two witnesses this morning should be up to the task, highly qualified.

Dr. Friedmann presently heads DOE's coal programs and has substantial experience working on energy projects at Lawrence Livermore National Laboratory, and Scott Klara, an authority on coal research from the National Energy Technology Laboratory understands the R&D challenges.

We look forward to having you give us the plain facts, not Washington spin. At the end of the day, straight answers will help this committee determine whether DOE is up to the task of shepherding the innovation that may dramatically advance coal-based power both in terms of efficiency and environmental goals.

But I worry that in the rush by the administration to implement new standards and regulations on coal-based power generation, the prospects for success or technological advancements are at risk. All these are questions we hope you can address today.

[The prepared statement of Mr. Murphy follows:]

PREPARED STATEMENT OF HON. TIM MURPHY

Today's hearing will review the status of the Department of Energy's clean coal programs. This oversight will be focused on the department's efforts to advance carbon capture and sequestration, or CCS, technologies at coal-based power plants.

Legislation and regulation in this important area should and must be based on sound scientific and economic facts. Where are we? Where are we going? When can we get there? How do we do it?

Today's testimony, which builds on our oversight work from this past October when we heard from workers and local officials whose coal-dependent communities are suffering in part because of EPA policies—will help us review exactly where DOE is today in its work on CCS. There are many questions about the current status of this technology. Answering these questions, and gathering the underlying facts, will help us understand how carbon capture technologies can work effectively and reliably on coal power plants. The testimony will also help the committee develop a clear and accurate record of what will be necessary—the innovation, the operational experience, the economics, the timeframes—to develop commercially competitive CCS for coal-based power generation.

The technical and economic issues DOE confronts are not everything that is needed to determine if CCS can work at a large level in our nation's electricity system. Various legal issues, regulatory issues, infrastructure issues all must be addressed appropriately.

Yet when looking at just the critical technical challenges to CCS for coal plants—challenges for which Congress has appropriated billions of dollars to DOE to address—we have a way to go, on several levels.

First, it has not yet been demonstrated that CCS systems will work reliably at full-scale coal power plants. It is not sufficient to rely upon paper estimates in laboratories or speculation from EPA lawyers about technological feasibility.

Carbon dioxide capture and compression systems have to be integrated into actual, full-scale coal power plants and be shown to operate reliably over time, while

maintaining predictable and safe plant operations. And it does not appear DOE will have complete answers about this for at least 6 to 10 years.

Second, the costs to produce electricity have to come down by a large amount to make any successfully demonstrated CCS systems commercially viable in the open market. The first generation CCS technology—because of increased capital and operating costs and decreased electricity produced for the electric grid—has been estimated to increase the cost of electricity significantly. At a coal gasification facility, the cost of electricity may be increased by 40 percent; at a pulverized coal power plant, by upwards of 80 percent. This is what DOE's own documents tell us.

Demonstrating full scale CCS is alone not sufficient to make it the standard for the nation's coal based electricity generation. If coal power plants cost too much, nobody will build them.

Energy costs will increase making it even more difficult for families and US manufacturers to compete.

Which brings me to the third point: the research, development, and innovative breakthroughs needed to produce economically viable CCS technologies for coal power will take operational experience and time, decades in fact. This is not my opinion; DOE's own R&D timetables make this point.

Over the past 10 fiscal years, more than $7.6 billion have been appropriated to DOE for its clean coal programs. This spending reflects the confidence Congress has placed in DOE and the National Energy Technology Laboratory, or NETL, to help advance these technologies.

Given this spending, and given the current economic and regulatory landscape, oversight is necessary to ensure DOE's stewardship of these funds and goals for its research are effective. It is also necessary to make sure energy and environmental policies match the technological realities. We are all committed to clean air. Period. But moreover, we must be committed to using North American energy resources rather than continuing our trillion-dollar trade deficit with OPEC, or our $4 trillion wards in the Mid East where we have to defend their oil fields.

In this hearing, I hope we will get some straight answers so that we can establish what is truly the status and prospects of DOE's game-plan for advancing coal power technologies. Our two witnesses this morning should be up to the task. Dr. Friedman presently heads DOE's coal programs and has substantial experience working on energy projects at Lawrence Livermore National Laboratory. And Scott Klara, an authority on coal research from the National Energy Technology Laboratory, understands the R&D challenges. I look to you to give us the plain facts, not Washington double-talk.

At the end of the day, straight answers will help this committee determine whether DOE is up to the task of shepherding the innovation that may dramatically advance coal based power, both in terms of efficiency and environmental goals. But I worry that in the rush by this administration to implement new standards and regulations on coal based power generation, the prospects for successful technological advancement are at risk.

# # #

Mr. MURPHY. And with that, I will now recognize Ms. Schakowsky, who is sitting in for Ms. DeGette for 5 minutes.

OPENING STATEMENT OF HON. JANICE D. SCHAKOWSKY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Ms. SCHAKOWSKY. Thank you, Mr. Chairman. I appreciate our witnesses appearing today to tell us about the progress of DOE's important carbon capture and storage research development and demonstration work. I often say that this Congress has an opportunity to lead this country into the future with smart action that will curb emissions and prevent irreversible climate change, but our window to take action is rapidly closing.

We know that the National Oceanic and Atmospheric Administration announced that 2013 was the fourth warmest year on record, and 9 of the 10 warmest years have occurred since 2000. For decades, the world's scientists have presented policy makers with evidence that climate change is happening and that human

activities are responsible. Those warnings have only grown stronger with time.

The president of the National Academy of Sciences has explained that scientists are now as certain about human-caused climate change as they are that smoking cigarettes can cause cancer. We need to drastically reduce our carbon emissions and quickly. We need to make a commitment to clean and renewable sources that provide all of the jobs and energy benefits of fossil fuels without the public health and environmental costs.

We also need to use the best technology available to reduce carbon emissions wherever we can. Carbon capture and storage or CCS is one of those technologies. CCS investments are proving that coal-fired power plants can capture a significant percentage of their carbon pollution and safely transport and inject it underground.

The Kemper facility in Mississippi set to go online later this year will be the first commercial scale coal-fired CCS project, but it is not the only one. There are projects in California, Texas, and elsewhere including my home state of Illinois that have attracted billions of dollars in private financing. Those projects are demonstrating all the individual elements of advanced CCS systems, carbon capture, compression, transport, and sequestration technologies.

In September, EPA proposed a rule requiring new coal-fired power plants to cut carbon pollution. To meet the proposed standards, new coal plants will have to use CCS technology to capture a portion of their carbon pollution. Opponents have argued that the EPA should not have a role in reducing carbon pollution from coal-fired plants and that CCS technology isn't available now.

In fact, this committee passed a bill just last week essentially eliminating EPA's authority to regulate carbon pollution from coal plants.

Today's hearing should provide some much needed facts about CCS and the economics of pollution controls. First there is a critical role for government to play. Right now, power plants can pollute without any adverse financial impact. There is no financial incentive for industry to develop and deploy pollution controls on a widespread basis.

If EPA doesn't require responsible action, we have no chance of protecting public health and our planet over the long term. It is also important to recognize that CCS technologies are already available. All the component pieces of CCS have been used in industrial applications for a long time. Industrial facilities have separated carbon dioxide for several decades. Oil companies have transported carbon dioxide by pipeline and injected it underground for nearly 40 years.

Existing DOE programs have helped apply those technologies in the power sector. Multiple demonstration projects have applied these technologies to coal plants. Several full-scale projects are under construction today, and many vendors are willing to sell CCS technologies right now.

CCS is the only proven set of technologies that would allow us to cut carbon pollution while still using coal. I look forward to hearing from our DOE witnesses today about their important contributions to our nation's vital effort to cut carbon pollution. And I don't

know if anyone would like the remaining time. I yield back. Thank you, Mr. Chairman.

Mr. MURPHY. Gentlelady yields back, and I now recognize Dr. Burgess for 5 minutes.

OPENING STATEMENT OF HON. MICHAEL C. BURGESS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TEXAS

Mr. BURGESS. Well, thank you, Mr. Chairman, and this hearing is the perfect example of our constitutional obligation, the constitutional obligation that is required of this subcommittee. On behalf of the taxpayers of this country, we are required to do oversight. We are required to ask the questions and get the answers. Our committee authorizes the expenditure of money. The appropriators write the check. The agency cashes the check, and it is our obligation to ensure that that money has been spent appropriately for the benefit of the taxpayer of this country.

Every program, every agency, should come under similar scrutiny. This is not partisan. It is not political. It is basic oversight and applying common sense principles to allow the government the opportunity to work more effectively and efficiently on behalf of the taxpayer.

So for over a decade, the Department of Energy has been focused on assisting industry to develop ways to reduce carbon dioxide emissions, most notably although not exclusively, through the carbon capture and storage techniques. Research and development for these technologies has cost the federal government billions of dollars.

So what did we get for the money we spent? Where does this technology stand? Are we nearing commercial viability? And if so, what is the timeline for your average generating plant to be able to acquire such technology?

In Texas, many questions remain as to how carbon capture and storage will affect neighborhoods and the environment around generation plants. When pressurized carbon is injected deep into the earth, how does that affect the ground above? Are people's homes and businesses at risk from seismic activity should this carbon accidentally be released? Will the earth's surface around such sequestration attempts be changed due to the injection of emissions? The federal government must be honest and must be up front with the American people as to the potential pitfalls as well as the benefits to such technology.

So over $7.5 billion has been appropriated over the last decade for the development of clean coal's technologies. We must have an accounting of every dollar and how the American taxpayer is better off by each dollar having been spent. Where has the money gone? What do we have to show for it? I hope these questions can be answered during today's hearing.

With eight demonstration projects of carbon capture and storage technology beginning around the country, two in my home State of Texas, how many are close to actual operation? How many are producing electricity that consumers can use today? And if they are producing electricity that consumers can use today, what effect has that had on the price for the consumer?

A lot is riding on this. The federal agency is setting regulations and standards based upon these demonstration projects. We need to know where they stand. So today's hearing is the kind of oversight this committee can do and should do. It is the kind of oversight that we do best. Asking questions as to how the authorizations passed by this committee are being utilized by the department and how the money the department received is being spent and ultimately how that benefits the taxpayer.

I thank the chairman for the recognition. I will yield back the time.

Mr. MURPHY. Gentleman yields back. Now recognize Mr. Waxman for 5 minutes.

OPENING STATEMENT OF HON. HENRY A. WAXMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. WAXMAN. Thank you very much, Mr. Chairman. The subject of today's hearing is one that is vital for the future of coal and the climate, the development of carbon capture and storage, or CCS technologies. Investments that the Department of Energy is making in CCS will help industry produce cleaner power, help provide a market for coal as the world moves to cut carbon pollution, and help avoid a catastrophic degree of climate change.

There is a long history of government investment driving private sector technological advances. Government investment led to the creation of the Internet, GPS positioning, and even Apple's voice assistant Siri. Google's Search algorithm was financed by a grant from the National Science Foundation.

In the case of CCS, DOE is partnering with the coal industry and utilities to build next generation clean coal power plants, helping to create new jobs and control carbon emissions. Investing in CCS makes sense because our nation and the world must reduce our carbon emissions.

My Republican colleagues accuse the president of waging a war on coal. In fact, the president is trying to create a future for coal. His administration has invested billions of dollars, more than any other administration, to develop clean coal technologies. It is the policies pursued by Republicans on this committee, not the president's policies, that are a real threat to coal.

In fact, I am confident that the coal industry and Republican members from coal states will soon regret the day that they opposed the Waxman-Markey Climate Bill and the $60 billion we proposed to invest in carbon capture and sequestration.

Mr. Chairman, this committee is powerful. We have the authority to shape our Nation's environmental and energy laws. But there is one set of laws we cannot change. Those are the laws of nature. The greenhouse effect tells us that we will irrevocably change our atmosphere and cause catastrophic climate change if we continue to burn coal without developing a technology to capture its carbon emissions. That is not a bright future for coal or any of us.

The DOE investments in CCS are under the spotlight now because of EPA's proposed new power plant rule, but these investments are crucially important and are starting to pay off. Later this year, Southern Company's Kemper County Energy Facility in

Mississippi will begin operations and capture 67 percent of its CO_2 emissions. DOE's $270 million investment helped to make this plant a reality and attracted billions of dollars in private financing.

Opponents of CCS say that technology used in Kemper's facility is too expensive. But the cost of virtually all new technologies decrease over time with experience, continued innovation, and economies of scale.

We have seen that repeatedly under the Clean Air Act with scrubbers, NOx controls, and mercury controls. The expert witnesses today will tell us that they expect to see similar cost reductions with CCS technology.

In contrast, the costs of climate disruption are only going to get worse, much worse, if we don't act now to cut carbon pollution. Our choice is a simple one. We can do nothing while coal plants continue to spew dangerous emissions into the air, endangering the welfare of our children and our planet. Or we can develop the new clean energy technologies of the future. The President and DOE Secretary Moniz have made the right choice, invest in CCS. Our choice should be to support them in this effort. Mr. Chairman, yield back my time.

Mr. MURPHY. Gentleman yields back. I would like to now introduce our panel today. Dr. Julio Friedmann is the Deputy Assistant Secretary for Clean Coal, Office of Fossil Energy at the Department of Energy. In this capacity, he is responsible for the DOE's research and development programs and advance of fossil energy systems, large demonstration projects, carbon capture utilization and storage, and clean coal deployment. Before assuming his current position, Friedmann was Chief Energy Technologist for Lawrence Livermore National Laboratory.

Scott Klara is accompanying Dr. Friedmann today, and he is currently the acting director of the Department of Energy's National Energy Technology Laboratory where he is responsible for managing the day-to-day execution of all aspects of the lab's mission. He has 22 years of federal government experience with NETL and its predecessor organizations.

I will now swear in the witnesses. You are aware the committee is holding an investigative hearing and when doing so, has the practice of taking testimony under oath. Do you have any objections to testifying under oath? Both witnesses say no, and the Chair then advises you that under the rules of the House and rules of the committee, you are entitled to be advised by counsel. Do you desire to be advised by counsel during testimony today? Both waive that.

In that case, if you will please rise and raise your right hand, I will swear you in.

[Witnesses sworn.]

Mr. MURPHY. Both witnesses answer in the affirmative, so you are now under oath and subject to the penalties set forth in Title 18, Section 1001 of the United States Code. You may now each give a 5-minute opening statement. Dr. Friedmann, we will begin with you.

TESTIMONY OF JULIO FRIEDMANN, DEPUTY ASSISTANT SECRETARY FOR CLEAN COAL DEPARTMENT OF ENERGY, ACCOMPANIED BY SCOTT KLARA, ACTING DIRECTOR FOR THE NATIONAL ENERGY TECHNOLOGY LABORATORY, DEPARTMENT OF ENERGY

Mr. FRIEDMANN. Thank you, Chairman Murphy, Ranking Member Schakowsky, Ranking Member Waxman, and other members of the subcommittee. Thank you for this opportunity to speak to you today. It is really an honor and a privilege.

By way of introduction, I am the only Julio Friedmann you will ever meet and was recently appointed to be the Deputy Assistant Secretary for Clean Coal in the Office of Fossil Energy. This is my second time testifying before this committee, my first time in this role.

Prior to that appointment, I served as the Chief Energy Technologist at Lawrence Livermore National Laboratory where I coordinated and managed energy research programs across laboratory. I have also worked in industry, 5 years at Exxon Mobil in Houston and in academia as part of the faculty of the University of Maryland.

I am joined today by Mr. Scott Klara. He is the acting director of our National Energy Technology Laboratory, the only government-owned, government-operated laboratory with the sole mission on fossil energy. Mr. Klara is responsible for the execution and management of the program work here where he served the Nation for over 20 years following a 7-year stint in industry.

We appreciate this opportunity to discuss the Department of Energy's coal research and development activities and carbon capture and storage in particular. It is worth noting that although I am the deputy assistant secretary for clean coal, carbon capture, and storage technology is not a coal technology per se. It is an environmental technology whose job is to reduce carbon dioxide emissions.

It has special relevance and importance to the coal-powered systems in this country and in particular the existing and future coal fleets. In that context, the Department of Energy continues to play a leadership role in the development of clean coal technologies with our focus on carbon capture and storage.

As part of this in December, the department released an $8 billion draft loan guarantee solicitation to promote the early deployment of innovative fossil energy technologies in projects that reduce carbon emissions. This solicitation is added to the already $6 billion the Obama Administration is committed to clean coal technologies. This reflects the president's commitment, continued commitment, to an all-of-the-above strategy. And it embraces an energy mix of nuclear power, renewable energy sources, and fossil energy including clean coal.

The clean coal research program is addressing the key challenges that confront the development and deployment of clean coal technologies. These include research and cost-effective capture technologies, the development and demonstration of advanced coal conversion and environmental control technologies, and the safe and effective storage of carbon dioxide in deep geological formations including monitoring, verification, and accounting systems.

To get there, we are pursuing three technical pathways for carbon capture: post-combustion, pre-combustion, and oxygen-fired combustion or oxy-combustion. Research in these pathways is exploring a wide range of approaches that, coupled with advances in efficiency improvement and cost reduction, including the developments in gasifications, turbines, and advance combustion systems, will help provide a technology base for commercial deployment of CCS broadly.

On the side of storage, we have pursued projects designed to develop innovative advanced technologies and protocols for the monitoring, verification, accounting of CO_2 storage in geological formations as well as simulating the behavior of geologically stored CO_2.

The regional carbon sequestration partnerships are an essential component of this effort and have successfully executed 19 small-to-large-scale CO_2 injection projects nationwide including Texas, Alabama, Mississippi, Ohio, Montana, Michigan, and Illinois. The program is currently in the development phase during which large scale field testing involves at least one million tons of carbon dioxide per project implemented. Several of the large scale tests are currently underway, and one project has safely injected over three-and-a-half-million tons of carbon dioxide which continue to be monitored for safe and permanent storage.

Right now, the crown jewels of our program are the eight major large CCS demonstrations deployed around the country. They are selected in part on three important bases: likelihood of technical success, likelihood of financial success, and covering a wide set of national needs. We have industrial and power projects, saline formation, and enhanced oil recovery projects, pre-, post-, and oxy-fired projects, and both new-build plants and retrofits.

The plants within our portfolio produce power, fertilizer, ethanol, and methanol. They are important advances in several aspects of these projects. For example, in east Texas, the Air Products and Chemicals, industrial CCS project is capturing CO_2 from two steam-methane reformation units, basically hydrogen plants.

The CO_2 captured there is being used for enhanced oil recovery operations, and will pass one million tons of total injection this fall. As mentioned by several members, the construction of Kemper County's IGCC project by Southern Company is near completion as is the completion of the Archer Daniels Midland Industrial CCS Project in central Illinois.

And just last month, FutureGen 2.0 moved closer to construction after the DOE approved the record of decision needed to go forward with continued work and spending.

Since the inception of the carbon storage program, the Department of Energy has recognized that a number of utilization technologies could also play important mitigating roles.

Aside from enhanced oil recovery though, the potential for these approaches is limited for a number of technical reasons including cost and market factors. In the meantime, enhanced oil recovery represents the most commercially attractive utilization option for CO_2 storage and produces substantial quantities of oil while storing carbon dioxide in geological formations.

There are currently six of those large eight projects which are employing CO_2 enhanced oil recovery, two doing saline and aquifer

storage projects across the U.S. As with the saline storage projects, the CO_2 EOR projects are subject to rigorous monitoring, verification and accounting procedures to validate the storage of CO_2 and verify their safety and effectiveness.

To conclude, Mr. Chairman, CCS can play a critical role in mitigating CO_2 emissions under many potential future carbon stabilization scenarios. Since challenges remain to commercial deployment of these technologies, it is the department's goal and the focus of our research efforts to spearhead the research and development that would not have occurred otherwise and has successfully leveraged private investments in advancing the readiness of these emerging clean coal technologies. Based on our, I believe, successful track record, I believe that our clean coal research program demonstrates that we can help meet the challenges associated with CCS deployment.

With that, Mr. Chairman, I would be happy to answer any questions you and the subcommittee have. Thank you for your attention.

[The prepared statement of Mr. Friedmann follows:]

Statement by Dr. S. Julio Friedmann
Deputy Assistant Secretary for Clean Coal
U.S. Department of Energy

Before the

Committee on Energy and Commerce
Subcommittee on Oversight and Investigations
U.S. House of Representatives

Carbon Capture and Storage

February 11, 2014

Thank you Chairman Murphy, Ranking Member DeGette, and members of the Subcommittee. I appreciate the opportunity to discuss the Department of Energy's (DOE) coal research and development (R&D) activities, including carbon capture and storage (CCS).

Coal fuels approximately 40 percent of our domestic electricity production. As the Energy Information Administration (EIA) recently pointed out in the Annual Energy Outlook 2014 reference case, coal will continue to be one of the two most important sources of electricity generation through 2040. Because it is abundant, the clean and efficient use of coal is a key part of President Obama's all-of-the-above energy strategy.

A major challenge to coal, however, is that it is a major source of carbon dioxide (CO_2) emissions. Therefore, it is critical that we promote currently available technologies and develop more economic and broadly available technologies to reduce those emissions from coal-fired power plants. To that end, the Obama Administration strongly supports the development of clean coal technologies, including carbon capture and storage, as a critical component to an energy-rich, environmentally sound energy economy. In addition to the Administration's annual budget requests, that support was made clear in the 2009 American Recovery and Reinvestment Act (Recovery Act), which provided $3.4 billion for CCS. This followed over 15 years of

appropriations that have provided the science and technology foundation for CCS deployment in the US and around the world. It was also evident in the formation of the Interagency Task Force on Carbon Capture and Storage, which the President charged in February 2010 to develop a plan to overcome the barriers to the widespread, cost-effective deployment of CCS within 10 years.

On June 25, 2013, President Obama laid out a broad Climate Action Plan to cut carbon pollution in America, prepare the United States for the impacts of climate change, and lead international efforts to combat global climate change. A key component of that plan is an $8 billion loan guarantee solicitation, which was released on December 13, 2013. The solicitation covers a broad range of advanced fossil energy projects, and is designed to support investments in innovative technologies that can cost-effectively meet financial and policy goals, including the avoidance, reduction, or sequestration of anthropogenic emissions of greenhouse gases.

As the President has made clear, fossil fuels – including coal – provide more than 80 percent of our energy today and they are projected to remain a large source of energy for decades. The fossil solicitation – in addition to the $6 billion the Administration has already committed to clean coal technologies – reflects the Administration's commitment to an "all of above" energy strategy that develops every available source of American energy – a strategy that's cleaner, cheaper, and full of new jobs.

Clean Coal Research Program

DOE continues to play a leadership role in the development of clean coal technologies with a focus on CCS. The Clean Coal Research Program – administered by DOE's Office of Fossil Energy and implemented by the National Energy Technology Laboratory (NETL) – is designed to enhance our energy security and reduce environmental concerns over the future use of coal by developing a

portfolio of cutting-edge clean coal technologies. The Program is well positioned to help overcome the technical challenges associated with the development of clean coal technologies.

The Clean Coal Research Program, in partnership with the private sector, is focused on maximizing efficiency and environmental performance, while minimizing the costs of these new technologies. In recent years, the Program has been restructured to focus on clean coal technologies with CCS. The Program pursues the following two major strategies:

1) capturing and storing greenhouse gases; and

2) improving the efficiency and footprint of fossil energy systems.

The first strategy aims to remove emissions of greenhouse gases from fossil fueled energy systems. The second strategy seeks to improve the fuel-to-energy efficiencies of these systems, thus reducing pollutant emissions, water usage, and carbon emissions on a per unit of energy basis. Collectively, these two strategies constitute the Clean Coal Research Program's approach to ensure that current and future fossil energy plants can contribute to a safe and secure clean energy future.

Core Research and Development Activities

The Clean Coal Research Program is addressing the key challenges that confront the development and deployment of clean coal technologies through research on cost-effective capture technologies; monitoring, verification, and accounting technologies to ensure permanent storage; and development of advanced energy systems. Research is focused on developing technology options that dramatically lower the cost of capturing carbon dioxide from fossil fueled energy plants. This research can be categorized into three technical pathways: post-combustion, pre-combustion, and oxy- combustion. Post-combustion refers to capturing CO_2 from the stack gas after a fuel has been

combusted in air. Pre-combustion refers to a process where a hydrocarbon fuel is converted to a mixture of hydrogen and carbon dioxide, and CO_2 is captured from the gas mixture before it is combusted. Oxy-combustion is an approach where a hydrocarbon fuel is combusted in pure or nearly pure oxygen rather than air, which releases energy and produces a mixture of CO_2 and water that can easily be separated to produce pure CO_2. We pursue all three pathways today because all three pathways are comparable in terms of cost and efficiency, and all have engineering strengths.

Collectively, research in each of these technical pathways is exploring a wide range of technical approaches such as hydrogen membranes; oxy-combustion concepts; solid sorbents; catalyzed solvents; advanced gas/liquid scrubbing technologies; and advanced hybrid concepts such as liquid membrane contactors.

These efforts cover not only improvements to state-of-the-art technologies but also development of several revolutionary concepts, such as metal organic frameworks, ionic liquids, enzyme-based systems, and chemical looping – a form of oxy-combustion that utilizes oxygen from metal oxide as an oxygen carrier for fuel combustion, or for making hydrogen by "reducing" water. In combustion applications, the products of chemical looping are CO_2 and H_2O as steam. Thus, once the steam is condensed, a relatively pure stream of CO_2 is produced ready for sequestration. This work has also led to manufacturing breakthroughs in microfluidics, nanofabrication, and molecular design. Coupling these developments with other advances in efficiency improvements and cost reduction from developments in gasification and turbines will help provide a technology base of fossil energy systems integrated with CCS that will be widely adopted.

Regional Carbon Sequestration Partnerships

The Regional Carbon Sequestration Partnerships were created by DOE in 2003 through a

competitive solicitation. The Partnerships were designed to address a range of issues associated with geologic storage of CO_2. The Clean Coal Research Program has been performing CCS field tests focused on injection, monitoring, verification, accounting and other aspects of geologic storage for many years, and the seven Regional Carbon Sequestration Partnerships are critical to this effort. These Partnerships are comprised of state agencies, universities, and private companies. They represent more than 400 unique organizations in 43 States, and four Canadian Provinces. Geographic differences in fossil fuel use and potential storage sites across the United States dictate the use of regional approaches in addressing CCS, so each Partnership is focused on a specific region of the United States and Canada that holds similar characteristics relating to CCS opportunities.

Together, the Partnerships form a network of capability, knowledge, and infrastructure that will help enable geologic storage technology to play a role in the clean energy economy. They represent regions encompassing 97 percent of coal-fired CO_2 emissions, 97 percent of industrial CO_2 emissions, 96 percent of the total land mass, and essentially all the geologic storage sites that can potentially be available for geologic carbon storage.

During the Validation Phase of the program, Regional Partnerships drilled wells and injected small quantities of CO_2 to validate the potential of key storage locations totaling more than 1 million metric tons of CO_2 at 19 small scale injection projects throughout the United States and Canada. Those tests helped to validate storage at a small scale to understand the fate of CO_2 in different depositional systems containing saline water, oil, and natural gas, and helped test and strengthen simulation and monitoring tools and approaches required for commercialization. The program is currently in the Development Phase, during which large-scale field testing involving at least 1 million metric tons of CO_2 per project will be injected. Tests are designed to not only investigate

commercial-scale injection of CO_2, but will also be used to understand the necessary regulatory, economic, liability, ownership, and public outreach efforts needed for successful CCS, and to develop the necessary human capital, knowledge base, and experience necessary to implement future CCS operations. Several of the large-scale tests are currently underway and one project has safely injected over 3.6 million metric tons and is being monitored for safe and permanent storage.

Over the course of these initiatives, DOE and the Partnerships are addressing key infrastructure issues related to permitting, pore space ownership, site access, liability, public outreach, and education. An important product of this work is a series of Best Practice Manuals on topics such as site characterization, site construction, operations, monitoring, mitigation, closure, and long-term stewardship. These Manuals will serve as guidelines for a future geologic sequestration industry in their regions, and help transfer the lessons learned from DOE's Clean Coal Research Program to all regional stakeholders. The first editions of the Best Practice Manuals are available on DOE's reference shelf [1] and the Manuals will be periodically updated as lessons learned from the large scale field tests are realized.

We have also pursued projects designed to develop technologies and protocols for the monitoring, verification, and accounting (MVA) of CO_2 storage in geologic formations as well as simulating the behavior of geologically-stored CO_2. MVA of geologic storage sites is an important part of making geologic storage a safe, effective and reliable method of greenhouse gas control. These activities will culminate in a set of best practices for the deployment of carbon capture, utilization and storage technology.

In addition to this foundational science, technology, infrastructure, and practice, DOE and the Partnerships continue to work closely with the Environmental Protection Agency (EPA) and

[1] http://www.netl.doe.gov/research/coal/carbon-storage/carbon-storage-infrastructure/best-practices

other Federal and state agencies in developing CCS regulatory strategies, which will provide additional certainty for future CCS deployments.

Demonstrations at Commercial-Scale

The Clean Coal Program's work is to meet the technical and economic challenges associated with the deployment of newer coal technologies. Commercial-scale demonstrations help the industry understand and overcome start-up issues, address component integration issues, and gain the early learning commercial experience necessary to reduce technology risk and secure private financing and investment for future plants.

The Department is implementing commercial-scale demonstration projects through the Clean Coal Power Initiative (CCPI), FutureGen 2.0, and the Industrial Carbon Capture and Storage (ICCS) programs. These projects together cover a wide range of important technologies, settings and potential applications. These include pre-, post-, and oxycombustion projects; new builds and retrofits; saline formation storage and enhanced oil recovery; siliciclastic and carbonate reservoirs; coal and petcoke conversion; power sector and industrial sector applications; and the geographic diversity that represents regulatory and economic diversity nationwide. The portfolio of projects is designed not only for technical and commercial success, but also to maximize learning and value to the public.

The CCPI is a cost-shared partnership between the Government and industry to develop and demonstrate advanced coal-based power generation technologies at the commercial scale. By enabling advanced technologies to overcome technical risks involved with scale-up and bringing them to the point of commercial readiness, CCPI accelerates the development of advanced coal generation technologies integrated with CCS. The CCPI also facilitates the movement of

technologies into the marketplace that are emerging from the core research and development activities.

The CCPI program received an additional $800 million from the Recovery Act which, in combination with base funding, was used to fund four CCPI Round III projects, of which two pre-combustion (new builds) and one post-combustion capture (retrofit) projects are still active. In addition, a CCPI Round II project, with Southern Company Services, was modified to demonstrate CCS at a new integrated gasification combined cycle power plant. Having completed all design, planning, and environmental review requirements, this project began construction in 2010 and project construction is now more than 75 percent complete.

The FutureGen 2.0 Project intends to conduct novel large-scale testing to accelerate the deployment of advanced oxy-combustion power production technologies integrated with CCS. This project will be the first advanced repowering oxy-combustion project to store CO_2 in a deep saline geologic formation. On August 5, 2010, then-Secretary of Energy Steven Chu announced an award totaling $1 billion in Recovery Act funding to 1) The FutureGen Alliance and 2) Ameren Energy Resources along with their partners (Babcock & Wilcox and Air Liquide Process and Construction, Inc.) to repower an existing plant with advanced oxy-combustion technologies. Together, these two awards comprised the FutureGen 2.0 project for clean coal repowering with CCS. On February 28, 2011, the FutureGen Alliance selected Morgan County, Illinois, as the preferred location for the FutureGen 2.0 CO_2 storage site, visitor center, and research and training facilities. The Alliance has subsequently taken over leadership of both projects comprising the FutureGen 2.0 program.

FutureGen 2.0 successfully completed Phase I, which included identification of a sequestration site, preliminary characterization and test drilling, and a commitment from the Illinois Commerce

Commission to cover the project's output under its purchasing plans. Phase II commenced on February 1, 2013. Last month, DOE issued a Record of Decision to provide financial assistance to the FutureGen Alliance for the project. The Department intends to provide approximately $1 billion of financial assistance for the project (the majority of which is authorized under the ARRA through cooperative agreements with the Alliance).

In addition to the CCPI and FutureGen 2.0 projects, the Recovery Act has also helped fund more than 80 additional projects, which includes three large scale ICCS demonstrations, 10 geologic site characterizations, 43 university research training projects, seven CCS research training centers, six ICCS projects focused on CO_2 reuse, and 14 projects focused on accelerated component development in the core research program.[2]

Examples of progress on these projects include the Archer Daniels Midland ICCS project in Illinois, which will demonstrate an integrated system of CO_2 capture in an ethanol production plant and geologic sequestration in a sandstone reservoir. This project is under construction and approximately 49 percent complete. In Texas, the Air Products and Chemicals, Inc. ICCS project recently began capturing CO_2 from two steam methane reformer hydrogen production plants for enhanced oil recovery (EOR) operations. This project is the first to capture CO_2 at large scale from steam methane reformers used for hydrogen production, with the captured CO_2 then utilized for EOR. In December 2013, the Department issued a Record of Decision on the Leucadia ICCS project in Louisiana, completing the environmental compliance process. When operational, this project will sequester 4.5 million metric tonnes per year of CO_2 for EOR.

[2] Details about all of the Fossil Energy projects funded by the Recovery Act can be found here: http://energy.gov/fe/fe-implementation-recovery-act.

It is important to understand that every large demonstration project matures through a series of stages, each of which requires important milestones and results. These allows the teams of managers at DOE headquarters and NETL to monitor progress, manage changing national and global commercial settings, and ensure appropriate use of public funds in support of the approved national objectives.

CO_2 Utilization Technologies

The coal research and development program has supported research on CO_2 utilization technologies for more than a decade. When the Carbon Storage Program (formerly named the Sequestration Program) was initiated in the mid-1990s, it was recognized that technologies such as mineralization, chemical conversion to useful products, algae production, enhanced oil recovery and enhanced coal bed methane recovery could play an important role in mitigating CO_2 emissions. Other than EOR, the CO_2 emissions reduction potential of these approaches is limited, due to factors such as cost and market saturation of salable byproducts. Even so, these approaches are logical "first-market entry" candidates for greenhouse gas mitigation, due to their ability to produce revenue from use of the CO_2 that could be used to offset the costs for these "early adopters." Hence, these options provide a technology bridge and smoother transition to the deployment of the large-scale, stand-alone geologic sequestration operations that will ultimately be needed to achieve the much larger emissions reductions required to approach stabilizing greenhouse gas concentrations in the atmosphere.

EOR represents the most near term and most commercially attractive utilization option for captured CO_2. Over the history of the Department, the focus of CO_2-EOR R&D has shifted from increased incremental oil production to monitoring, verification, and accounting of geologically stored CO_2

as part of a climate change mitigation strategy. As early as the 1970s, DOE-funded projects were developing concepts to improve the effectiveness and applicability of CO_2-EOR. Currently, most commercial EOR projects have been strategically located near cheap sources of naturally occurring CO_2 or along pipelines from such sources. If research into reducing the cost of CO_2 capture from power plants proves successful, anthropogenic sources of CO_2 may become readily available for EOR projects.

The DOE's 2012 Carbon Utilization and Storage Atlas of the United States projects a potential CO_2 storage resource estimate of over 200 billion tonnes for oil and gas reservoirs in the United States. In the near-term, incremental oil produced via EOR using anthropogenic CO_2 could help offset the costs of CO_2 capture. The prospect of relatively low-cost supplies of captured CO_2 in widespread areas of the country could, in turn, provide the impetus for a national re-evaluation of the EOR potential in many mature fields. While conventional EOR is a widely-used process, CO_2 capture and permanent storage is not yet widely used at power plants. Continued evolution of EOR and transformational advances in development and deployment of CO_2 capture from coal power could help realize the synergy between the coal/power industry and the oil industry. Utilization of the CO_2 in EOR will impart knowledge that will be instrumental in the Department's continued focus on R&D in other geologic storage formations such as saline that have a larger storage potential for CO_2.

Conclusion

Today, nearly three out of every four coal-burning power plants in this country are equipped with technologies that can trace their roots back to DOE's advanced coal technology program. These efforts helped accelerate production of cost-effective compliance options to address legacy

environmental issues associated with coal use. CCS and related clean coal technologies can play a critical role in mitigating CO_2 emissions under many potential future carbon stabilization scenarios. CO_2 utilization technologies with salable byproducts are logical "first market entry" candidates for greenhouse gas mitigation due to their ability to produce revenue from the use of CO_2. EOR will be the dominant utilization opportunity in the near term and will impart additional experience that will be useful in the Department's continued focus on R&D in other storage formations, such as deep saline aquifers, necessary to address climate change. Nevertheless, challenges remain to promote currently available technologies and develop more economic and broadly available technologies for deployment of CCS. The Department's research programs and efforts have spearheaded R&D that would not have occurred otherwise and has successfully leveraged private investment in advancing the readiness of these emerging clean coal technologies.

Mr. Chairman, and members of the Subcommittee, this completes my prepared statement. I would be happy to answer any questions you may have at this time.

Mr. MURPHY. Thank you. Mr. Klara, we understand you are here to answer questions but not to provide an individual statement. So thank you. So I will recognize myself first for 5 minutes.

Dr. Friedmann, thank you for that testimony. The DOE's fossil energy office is responsible for overseeing all of DOE's research and development and demonstration work for clean coal technologies. Am I correct on that?

Mr. FRIEDMANN. Yes, sir.

Mr. MURPHY. Thank you. And you are the person in charge of the clean coal work and report to the assistant secretary, correct?

Mr. FRIEDMANN. That is correct.

Mr. MURPHY. OK, the project and research evaluations funding recommendations come from your people, your team. Is that right too?

Mr. FRIEDMANN. Yes, in partnership with NETL.

Mr. MURPHY. And, Mr. Klara, quickly, I know and respect the National Energy Technology Laboratory, but for the record, NETL brings the science, the technical and engineering expertise to DOE's programs, and your people do the research and development and conduct day-to-day project management. Is that correct?

Mr. KLARA. Correct.

Mr. MURPHY. Make sure your microphone is on. Now, Dr. Friedmann, carbon capture and sequestration has never been implemented commercially yet on a full scale at functioning power plants. Is that correct?

Mr. FRIEDMANN. That is a moving definition, sir.

Mr. MURPHY. But so far. You are anticipating that it is going to happen, but it hasn't happened yet. Am I correct?

Mr. FRIEDMANN. No, again it is a moving definition.

Mr. MURPHY. What does that mean?

Mr. FRIEDMANN. For example, we have deployed carbon capture and storage at the Beulah Gasification Facility for over 30 years and done carbon capture and storage from there for enhanced oil recovery for over 10 years. That produces high quality natural gas which goes into a pipeline that powers power plants.

Mr. MURPHY. All right, I am talking about commercial. Are those commercial plants, research plants?

Mr. FRIEDMANN. No, that plant has been in commercial operation for 30 years.

Mr. MURPHY. OK, I am talking about coal power plant.

Mr. FRIEDMANN. That is Burns North Dakota Lignite, sir. Yes, it is a coal plant.

Mr. MURPHY. Now, there presently are five coal powered demonstration projects as part of the DOE funding. Is that correct?

Mr. FRIEDMANN. Yes, five power projects.

Mr. MURPHY. One is FutureGen 2.0 which you refer to, and four are authorized under the Energy Policy Act of 2005. Is that correct?

Mr. FRIEDMANN. I am sorry. Can you say that again, please?

Mr. MURPHY. One is the FutureGen which——

Mr. FRIEDMANN. Yes.

Mr. MURPHY [continuing]. You mentioned, and four others are authorized under the Energy Policy Act of 2005.

Mr. FRIEDMANN. Yes, sir.

Mr. MURPHY. OK, now pursuant to the Energy Policy Act, the technologies of these power plants supported by DOE go well beyond the level of what is commercial service at coal power plants or has previously been successfully demonstrated on coal power plants. Is that correct?

Mr. FRIEDMANN. I would say that is fair.

Mr. MURPHY. OK, and the point of the current demonstrations according to your agency is to demonstrate that CCS can be integrated at commercial scale while maintaining reliable, predictable, and safe plant operations. Is that correct?

Mr. FRIEDMANN. Yes, sir.

Mr. MURPHY. Thank you. But DOE says it won't really know the result of these demonstration projects until they are completed and evaluated. Is that correct?

Mr. FRIEDMANN. The technical findings from these projects have been brought forward as the projects proceed. So again even though it is not a power project, I would point to the air products project in Texas which came online earlier this year, and the technical findings and results from that are already available. And as more come forward, more are available.

Mr. MURPHY. Now, I understand that reporting these demonstrations, according to your own project schedule, to take 6 to 9 years——

Mr. FRIEDMANN. Yes.

Mr. MURPHY [continuing]. For many of these? OK, thank you. Mr. Klara, we have spoken about this before. NETL says that the CCS technologies in a current state of development are cost prohibitive for full commercial service. What is a realistic timeframe based on NETL's best estimates for a commercially viable technology successfully completing demonstration and coming to market?

Mr. KLARA. With our program, we divide our technology up into three development buckets. We call them first generation technology, second generation, and transformational. And with each one of those development horizons, the cost and performance gets better. The first generation technology are the technologies that you will find in our current demonstration program. And these technologies indeed can be commercially offered and commercially deployed. With any development, and I think Congressman Waxman referred to this relative to NOx and SOx control, that with any development that with a learning curve as well as continued development within the Office of Fossil Energy's Program, you can't expect those costs to go down and the performance to increase.

Mr. MURPHY. But your documents suggest it will take until after about the mid 2020s for second generation technologies and more than 20 years for what you call transformational technologies. Am I correct in what your documents say?

Mr. KLARA. The additional buckets of technology, second generation and transformational, will indeed take some more time to achieve.

Mr. MURPHY. So why do you believe that those estimates are realistic? What will take the time?

Mr. KLARA. I am not sure I understand when you say when do we believe.

Mr. MURPHY. Well that it is going to take to the mid 2020s or longer. Why do you believe those timeframes are needed?

Mr. KLARA. Well, with every bucket of our technologies, we are constantly evaluating the R&D portfolio every year looking at how developments are proceeding as well as the scope of the portfolio. Some projects drop out. Additional projects are brought in. And as part of that, we are constantly doing analysis to evaluate when and to what level we believe those technologies will achieve.

Mr. MURPHY. Do you also assess commercial viability in that process?

Mr. KLARA. We assess the cost and performance. We rely on industry and others to determine when it is viable.

Mr. MURPHY. OK, thank you. I see my time has expired. Mr. Klara, when you talk, if you could move that microphone closer to your face. Now recognize Ms. Schakowsky for 5 minutes.

Ms. SCHAKOWSKY. I wanted to underscore something you said. You said that there is CCS technology in play used right now commercially and has been for several years. Is that true?

Mr. FRIEDMANN. Yes, it is. There is commercially available technology that can be sold by a wide number of vendors, U.S.-based and international with the heavy of equipment manufacturing made in this country. Pursuant to the earlier conversation, most of those technologies have been applied to industrial facilities. For example, the Beulah site is a synthetic natural gas plant.

But in point of fact, the same technologies have been demonstrated around the world in other coal-fired facilities.

Ms. SCHAKOWSKY. And would that technology fit into bucket one? Is that what you are saying?

Mr. FRIEDMANN. Yes, first generation.

Ms. SCHAKOWSKY. And to what extent does that reduce then the carbon pollution? I mean you are saying that we want to get to the third generation.

Mr. FRIEDMANN. Right, so that actually varies by site and by plant. Some of the plants, for example the Beulah one I mentioned before, basically acts as about a 50 percent decarbonization. Other plants we have seen, for example, the Air Products plant is essentially 90 percent decarbonization. We believe FutureGen will be effectively 100 percent decarbonization when it is active. But it depends on the technology. It depends on the plant. It depends on the type of coal used and has to be calculated as such.

Ms. SCHAKOWSKY. I think what we are going to hear today is that somehow this technology is not ready for commercial use, that the production and the timeline is very long and that what the president is doing to regulate carbon pollution from new coal-fired power plants is not appropriate. Could you comment on the veracity of that argument?

Mr. FRIEDMANN. We see our role chiefly as enabling the reduction of cost and the improved performance of these technologies as they enter the market and to work with commercial industrial partners on the commercialization themselves. Our job is not the commercialization or the determination of economic viability. Our job is to support the technology and the development of that.

Ms. SCHAKOWSKY. OK, am I correct that there are three basic steps in CCS, separately and compressing CO_2, transporting it by pipeline and injecting it underground?

Mr. FRIEDMANN. Correct.

Ms. SCHAKOWSKY. And, Dr. Friedmann, do we know how to separate and compress CO_2 with current technology?

Mr. FRIEDMANN. Yes, we do.

Ms. SCHAKOWSKY. And have we figured out how to transport CO_2 by pipeline?

Mr. FRIEDMANN. Yes, ma'am.

Ms. SCHAKOWSKY. And do we understand how to inject carbon into the ground? Is there enough viable storage underground to ensure that we can inject CO_2 without constraints? And a safety question was raised as well.

Mr. FRIEDMANN. Yes, ma'am.

Ms. SCHAKOWSKY. And so the basic building blocks are all technologically viable?

Mr. FRIEDMANN. The large-scale components of CCS have been shown and demonstrated. And that is an important technical finding.

Ms. SCHAKOWSKY. OK, finally, Dr. Friedmann, are there companies today that will sell technology to power plant operators looking to implement CCS technology?

Mr. FRIEDMANN. Yes, ma'am, with a performance guarantee.

Ms. SCHAKOWSKY. With?

Mr. FRIEDMANN. With a performance guarantee.

Ms. SCHAKOWSKY. So it sounds as if CCS is both real and available. We also hear from the Republicans that CCS simply costs too much, but the history of large-scale technology development and the Clean Air Act in particular is full of examples of pollution control costs decreasing over time with continued innovation and economies of scale as technologies mature and become widespread, costs naturally come down. Would you anticipate that CCS costs will come down as the technology matures and is put in place in more locations?

Mr. FRIEDMANN. Indeed.

Ms. SCHAKOWSKY. And why would that happen?

Mr. FRIEDMANN. As with all clean energy technologies, the value comes from deployment and cost reduction comes from deployment. Engineers learn things, and they come up with new ideas. We have seen this for many, many different kinds of technology deployment, but it has been clearly demonstrated for many energy technologies as well, from wind turbines to solar panels to coal gasifiers to many other kinds of technologies. And based on our thermodynamic assessments and based on our engineering assessments, we see multiple clear pathways to substantial cost production.

Ms. SCHAKOWSKY. Thank you. It seems to me what we can't afford is the cost of carbon and other pollution from coal. And as Mr. Waxman said, what we are hoping for today is both to help the environment and coal. And I yield back.

Mr. MURPHY. Gentlelady yields back. Can you just clarify on her question? Were you referring to costs going down on current plants or future plants?

Mr. FRIEDMANN. Both.

Mr. MURPHY. OK, so current plants that have already made their investment will see their cost decline because they are saying they will make further investments. I just want to make sure on her question.

Mr. FRIEDMANN. Thank you for providing me the opportunity to clarify that. That is an excellent question. Any retrofit to an existing power plant will necessarily add cost, but the cost of abatement itself today is a certain price and will go down over time as more technology is developed and deployed.

Mr. MURPHY. Thank you. Now recognize the Chairman Emeritus of the Committee, Mr. Barton, an engineer himself.

Mr. BARTON. Well, thank you, Mr. Chair. I am not a registered professional engineer anymore. I used to be, but to the registered professional engineers, that is as it should be a sensitive issue. So I have been registered, but I am not at this time. But I was trained as an engineer and did practice as a registered professional engineer.

I know that the purpose of this hearing is not on the legality of these standards, but I do just want to point out that in the Energy Policy Act in 2005, there is a section 402(i) that very specifically says that these clean coal standards cannot be set on projects that are demonstration projects that are receiving assistance. It is explicit. The chairman and several others of us have sent a letter to the EPA and DOE on that. I mean to EPA, but that is a subject for a different issue.

My generic question is pretty straightforward. All of these carbon capture sequestration technologies add cost to these coal plants. Could you all give the subcommittee kind of a baseline estimate of how much it adds to the cost? Does it double the cost? Does it increase it by 25 percent, 50 percent? What is the generic estimate?

Mr. FRIEDMANN. Thank you very much for your question. I am happy to provide that answer. It is a question that a great number of people are asking. First a quick caveat. Again that number, the precise number, will vary by plant whether it is subcritical or supercritical by coal rank, and by the kind of technology used.

Typically we express these costs as a range. So for the first generation technology that Dr. Klara was mentioning earlier, we are looking at something on the order of $70 to $90 a ton. In that context, that looks something like a 70 or 80 percent increase on the wholesale price of electricity.

For the second generation technologies, which we are developing, it is our strong expectation that that number will be roughly half. We will be looking at something like a $40 or $50 a ton cost.

Mr. BARTON. So the initial technology almost doubles the cost, and the next generation is going to add 25 percent to the cost. Is that fair?

Mr. FRIEDMANN. Again with respect to the wholesale price, yes. The retail price, of course, will vary by market. One of the points that I would like to make though, it is in fact a substantial percentage increase in the cost of electricity. But in part, that is because the current price of coal is so low that it represents a large percentage increase.

Mr. BARTON. Now, what has to happen to go from doubling to only increasing by 25 to 50 percent? What is the timeframe for

that? And how many plants have to be built and how many more billions of dollars or hundreds of millions of dollars have to be spent?

Mr. FRIEDMANN. I am going to answer partly and then leave the rest of the answer to Mr. Klara for that. Again we have laid out a very clear road map for R&D programs, and we believe that we will hit the marks that we have laid out in terms of major milestones and deliverables. We are looking towards a second generation of demonstrations coming forward in the next few years. They would be completely deployed and the learnings provided back to the public about the middle of the next decade, 2022 to 2025 timeframe. And those second generation demonstrations would have substantially reduced costs. Mr. Klara.

Mr. KLARA. Yes, and I will just confirm what Dr. Friedmann said in terms of a 10 year or less timeframe to get to that second generation developmental efforts. Relative to costs to do that, our assumption for that is that we will have levels commensurate with what we have today going forward. And that is our basis in determining if and when we can hit those marks. And again the 10-year time horizon or less is the horizon we believe we are looking at right now for these.

Mr. BARTON. So 10 years is good. Now, all of these demonstration projects, I believe, so far are on capture and sequestration, but former Congressman Rick Boucher when he was on the committee and the subcommittee chairman of the Energy Subcommittee had a bill that he tried very hard to get me to cosponsor. I never was able to unfortunately, but I got him to put in that bill some language on conversion of CO_2. I happen to think that it is going to be much more cost effective to convert CO_2 as opposed to capture and sequester it. Is EPA or DOE doing any research right now on CO_2 conversion as compared to capture and sequestration? And this will be my last question.

Mr. FRIEDMANN. Yes, sir. The good news is indeed we are. In addition to carbon capture and storage, we also do research in carbon utilization which includes using CO_2 to make beneficial products or converting the CO_2 into other substances or products themselves. Currently the majority of that effort is in enhanced oil recovery, which provides many benefits to the country including domestic secure fuel supply at low cost. There are other pathways to utilization which we are pursuing. There is a project actually in Texas, the Skyonics Project which we are piloting at about $110 million. That is going to convert carbon dioxide to basically mineral aggregate and cement admixtures.

We are also looking at converting carbon dioxide into algae and then that algae into other useful products including animal feed on one end of the spectrum and possibly biofuels on the other. We have a project at the Polk Plant in Florida where we are doing that today.

Mr. BARTON. You were ready for that question. Thank you.

Mr. MURPHY. The gentleman's time has expired. Now recognize Mr. Waxman for 5 minutes.

Mr. WAXMAN. Thank you, Mr. Chairman. Well that is what this hearing is all about, so I would expect you to be ready for all of

our questions since this is the field in which you both work so carefully.

Industry can pollute because it costs less to dump pollution than to pay to clean it up. Unfortunately dumping pollution is never really free. There are costs. The American people bear those costs and bad health, and our environment is also polluted. And we pay a price for that. So the Clean Air Act is one of the most successful environmental laws in the world, and one reason the Clean Air Act works so well is that it sets standards to drive technological innovation in pollution controls often called technology forcing standards.

Currently there are no limits on carbon pollution from coal-fired power plants. These plants are allowed to emit unlimited carbon pollution into the atmosphere, and that is just what they do. EPA is proposing carbon pollution standards that would address this problem by requiring the new power plants, coal-burning power plants, to reduce carbon pollution by 30 to 50 percent through the use of partial carbon capture and sequestration technology or CCS.

Dr. Friedmann, if we didn't have an EPA requirement, would you expect the power sector to use CCS at new coal-fired power plants?

Mr. FRIEDMANN. It is unlikely that they would deploy CCS technology in large part because they would not be able to get return on their investments through the public utilities commission process.

Mr. WAXMAN. And they don't want to make an investment on something where their competitors aren't spending that money either. Isn't that correct?

Mr. FRIEDMANN. It is worth mentioning that I am not a utility executive, but that has been my experience.

Mr. WAXMAN. Well, if you don't have this requirement, why spend the money? Why would a coal company or a power plant want to spend the money if they didn't have to if they could do it without having to spend the money and they can continue doing business as usual?

In 2011, American Electric Power abandoned its plan to install full-scale CCS at the Mountaineer Plant because the company could not recover its costs in the absence of a government requirement. So without a mandate, we are not going to get carbon pollution controls on coal, and that is why EPA rules are so essential.

Of course, government can also help industries develop the technology to meet pollution standards. There is a long history of government investment spurring private sector innovation in areas such as defense, technology, energy development. Even small government investments can produce big gains for the public and create huge new markets. Dr. Friedmann, isn't this what your office does? You invest in new technologies and work with the private sector to help clean up coal?

Mr. FRIEDMANN. Indeed it is. We spend our appropriations with the purpose of developing this technology, demonstrating its validity, and helping commercialize it in partnership with both utilities and heavy equipment manufacturers and other industrial partners.

Mr. WAXMAN. Besides CCS, what are some examples of pollution control technologies for coal or coal efficiency technologies that DOE has invested in and helped bring to market?

Mr. FRIEDMANN. One example is the TRIG Gasifier. The transport gasifier was developed as a partnership between Southern Company and the Department of Energy over the past 30 years. That is the core technology in the Kemper County demonstration, and we have helped bring that from pilot reactor scale up to large scale commercial demonstration.

Another example is a coal drying technology. This was funded actually between 2000 and 2004 in North Dakota with the Coal Creek Plant in which the lignite drying was used to increase the efficiency of the power plant output and did so between two and four basis points on the plant.

Mr. WAXMAN. So you had SCR and more efficient boilers. Is that right?

Mr. FRIEDMANN. SCR is another technology which desulfurization and de-NOx technology, mercury technologies, they are all technologies which the Department of Energy has supported over the years.

Mr. WAXMAN. But we have a long record of DOE's investments and EPA standards that work hand in hand. For example, DOE funded the first U.S. demonstration of a technology, this SCR, the selective catalytic reduction, which was ultimately used to comply with EPA's NOx standards in the 1990s. The same is now true with CCS. DOE has helped develop the CCS technologies needed to reduce carbon pollution from new coal-fired power plants, and now EPA has proposed reasonable standards that will take advantage of these demonstrated technologies to reduce carbon emissions.

Dr. Friedmann, what are the other advantages of these government investments? Do you think there will be a global market for American CCS technologies?

Mr. FRIEDMANN. Indeed we are already seeing that. We are seeing companies around the world, most notably in Japan and in China, which are interested in United States technology that is considered clean coal technology both because of high efficiency and because of potential for carbon capture.

Mr. WAXMAN. So it is good for American business? We can export this?

Mr. MURPHY. The gentleman's time has expired.

Mr. WAXMAN. Well, I want to at least go as long as my colleague.

Mr. FRIEDMANN. I think that would remain to be seen.

Mr. MURPHY. He went over 55 seconds, so——

Mr. WAXMAN. So I think we ought to celebrate the ability of the new technologies to go along with the standards because it is going to be a win-win proposition. Thank you, Mr. Chairman, for your indulgence.

Mr. MURPHY. We will get the facts. You are welcome. I will now recognize Dr. Burgess for 5 minutes.

Mr. BURGESS. Thank you, Mr. Chairman. Again, thanks to our witnesses for being here and being so thoughtful in your preparation and your answers. Can we talk just a little bit about the feasibility and what you have been able to demonstrate commercially? I mean, I get it that small projects may hint at the feasibility of doing this type of activity. But where do you think we stand as far as pushing at the commercial viability? Because after all, that is

what I think the government investment was working toward, not just an interesting experiment but something that will actually work. So can you give us a sense of that feasibility versus commercial viability?

Mr. FRIEDMANN. Absolutely. Thank you for your question and again this is a core question which is asked of the CCS community regularly. I am happy to provide some clarification. As I mentioned before, this first generation CCS technology is commercially available today. You can call up a number of U.S. and international manufacturers, and they will sell you a unit at a large scale for capture of more than a million tons per year. In fact, a number of our large projects, for example, the Petro Nova Project in east Texas is run by NRG, in fact is using commercially available post-combustion capture technology unit. That procurement we expect to happen this year after they reach financial closure.

Mr. BURGESS. Now do you have any projection for the return on investment, say for that NRG project in east Texas?

Mr. FRIEDMANN. Thank you. I am very happy to answer that question. Again this is an important one, and it will take just a moment to answer so please bear with me. We consider it an important function of the Department of Energy and as a government public goods return to help fund the first-of-a-kind project. First-of-a-kind projects are not projects which a bank will finance ever. So typically we provide anywhere from 10 to 30 percent of the cost share into a project to match the private capital do the rest.

It is also our experience that the second-of-a-kind project is something the market takes on itself. In our communications with NRG so far, they have been very pleased with the return on investments they are going to get, granted given that government money that helped get the project over the top. In large part, that is because of the return on investment from enhanced oil recovery revenues. And they purchased a component, an equity into the field which are producing additional oil from the CO_2 injections.

The last thing I wanted to say on this is that they have also told us that they believe that what they have learned on the first project is sufficiently good that they can do a second project and get sizable returns on investment without government assistance.

Mr. BURGESS. And have they prepared for you then any sort of pro forma or any type of accounting where the taxpayer investment may be expected to return a yield in the future?

Mr. FRIEDMANN. One of the things that is important about the deployment of these technologies is that it spurs new business models. One of the things that we have seen is they are creating a new business model by aggregating and holding company projects like this one and the other to get those returns.

Mr. BURGESS. Yes, my time is going to run out, so I am going to need to interrupt you. I am not trying to be rude here, but you did, I think, reference into another question that some of this activity has been going on for what did you say, 30 years or 35 years in the commercial production of carbon for oil recovery? Is that correct?

Mr. FRIEDMANN. Yes, sir.

Mr. BURGESS. So at what point? It has been 30 or 35 years. At what point can we expect to see a return on investment if there is in fact a commercial application for recovered carbon dioxide?

Mr. FRIEDMANN. For most applications in the power sector, which is the area of greatest concern, I believe, to this committee, there is still a gap between how much you can sell CO_2 for in post-combustion and how much you can—how much it costs to deploy. A typical CO_2 off-take agreement for enhanced oil recovery is between $30 and $40 a ton. Typical post-combustion capture is between $40 and—I am sorry—is between $70 and $90 a ton. And you can't make that up on volume.

Mr. BURGESS. No, you can't.

Mr. FRIEDMANN. So that is part of the basis on which we continue to develop low cost technologies.

Mr. BURGESS. Again I am going to interrupt you because I need to go in another direction very quickly. I mean we are—in my home State of Texas, energy production is a big deal. There are some concerns surrounding a different type of energy technology and energy production with recent effects on seismic activity. Now, the head of the Texas Railroad Commission came and talked to us in 2005. He said the State of Texas was going to take title to the carbon that was being sequestered at one of the projects. How important is that that a state take that title to that compound? And then I guess the inference in that is the state would then have the liability that would not be borne by the industry.

Mr. FRIEDMANN. We continue to do work with the Bureau of Economic Geology, which is in close partnership with the Railroad Commission in Texas. We have a number of programs in our house which look at the potential risks associated with CO_2 leakage, events like seismicity and how to manage those and monitor it well. The questions of long-term liability are ones which still remain open. There are many, many potential policy pathways to manage transfer of liability and these sorts of issues.

At this point, I believe that mechanisms like the one you described were put in place in part to attract industry to find ways to make it more advantageous and more possible in a state such as yours and Texas to execute CCS projects.

Mr. BURGESS. Thank you. Thank you, Mr. Chairman.

Mr. MURPHY. The gentleman's time has expired. Now recognize the gentlelady from Florida, Ms. Castor, for 5 minutes.

Ms. CASTOR. Well, good morning, and thank you, Mr. Chairman, for calling this Oversight hearing on the Department of Energy's clean coal initiatives. Last June, President Obama issued a climate action plan, correctly noting that we have a moral obligation to leave our children a planet that is not polluted or damaged.

One way we can do that is through smart, clean technology investments like the kind that the Department of Energy is demonstrating with the next generation of power plants that employ carbon capture and storage. And I would like to find out from our witnesses how they believe their work fits in with the president's climate action plan and how the clean coal research program is helping to combat climate change and reduce emissions of harmful greenhouse gases.

Dr. Friedman and Mr. Klara, coal constitutes a significant percentage of this country's carbon emissions, approximately 30 percent. So logically cleaning up coal is essential to tackling climate change. Do you both agree with that statement?

Mr. FRIEDMANN. I am sorry. Could you make that statement again? I want to make sure I am answering correctly.

Ms. CASTOR. Coal constitutes a significant percentage of the country's carbon emissions, approximately 30 percent. So logically cleaning up coal is essential to tackling climate change.

Mr. FRIEDMANN. There have been many economic analyses of a whole slate of clean energy technologies, and what has been the overwhelming conclusion of all of those studies is that if you take any clean energy technology option off the table, the cost of reducing CO_2 emissions globally goes up. If you don't have an option like CCS, the total cost of managing climate change goes up. But that is true of all of the clean energy technologies.

Ms. CASTOR. Mr. Klara?

Mr. KLARA. And I think it is important to note also that our technology set is not just about coal. Our technology set is about CO_2. So if you look at the capture technology portfolio, most if not all of those technologies could work on natural gas, fire electricity, et cetera. If you look at the transport and storage component, a CO_2 molecule is a CO_2 molecule.

So the importance here is that the portfolio is truly a global portfolio that could impact future CO_2 emissions.

Ms. CASTOR. Now, your testimony so far has illuminated that you have done substantial work on clean coal and carbon capture really probably more than most people appreciate that has been going on not just under the Obama Administration but under the Bush Administration before that.

But now with the new climate action plan that is very broad-based and focused on a number of different strategies to reduce carbon pollution, Dr. Friedmann, how do the Department of Energy's carbon capture and storage investments fit in with the president's climate action plan?

Mr. FRIEDMANN. It is actually literally central to the plan. It is in the middle of the document that carbon capture and storage is an important part of the strategy, and the basis for that is what I described before. Removing any option actually ends up increasing the net cost of the body public.

Ms. CASTOR. And are there any other coal technologies that can reduce carbon pollution as much as carbon capture and storage?

Mr. FRIEDMANN. There are many coal technologies that could improve the efficiency of coal conversion that could reduce the emissions some. In order to dramatically reduce CO_2 emissions, carbon capture and storage would be required.

Ms. CASTOR. OK, if the Department of Energy and researchers and your industry partners are able to successfully develop and advance CCS technology portfolio for large-scale deployment by 2020, what kind of impact do you think that could have on CO_2 emissions and our climate?

Mr. FRIEDMANN. That ultimately really is a function of the rate of deployment, and the rate of deployment is contingent on many, many things. It is our hope to see increase in large-scale deploy-

ment quickly so that, say by 2050, somewhere between 12 and 20 percent of U.S. emissions and 12 and 20 percent of global emissions would be managed through carbon capture and storage.

Ms. CASTOR. OK, well I am glad the Department of Energy is making these important investments because the dangers of climate change are real. The costs that face our communities all across this country are very significant, the costs to all Americans, the cost to businesses. We simply cannot put our head in the sand. Yet you see power plants today. They still have that business incentive to emit unlimited amounts of carbon into our atmosphere, and that means the rest of us will pay the price. So we have got to work on this together. It is important that we make smart, clean technological investments now. Otherwise, we will not only make climate change worse, but we will make it harder and more expensive to address the problem in the future. And we can't afford to ignore the crisis. This is America, and we can tackle this together. Thank you very much.

Mr. MURPHY. Thank you. The gentlelady's time has expired. Now recognize Dr. Gingrey for 5 minutes.

Mr. GINGREY. Dr. Friedmann, you have been so accurate in answering all these questions. I am thinking about asking you your opinion on how much CO_2 would be released into the operating room if you did a hysterectomy by robotic surgery versus the open convention method. I am just kidding, of course. I won't ask you that. You probably would have the answer to it.

The first generation CCS project is currently on the way to full-scale demonstration do not all demonstrate the same technologies, do they?

Mr. FRIEDMANN. No, sir.

Mr. GINGREY. What is the value of demonstrating different types of technologies?

Mr. FRIEDMANN. Let me start answering this and then leave Mr. Klara some time as well. Today on a thermodynamic basis and on a cost basis, all of the pathways look equally viable. Given that, it is hard to decide which technologies the market will select based on engineering and based on long-term cost reduction and viability. That is the basis on which we are pursuing pre, post and oxy-combustion pathways because on a thermodynamic limit basis and on an engineering improvement basis, they all look like they could be winners.

Mr. GINGREY. Before we go to Mr. Klara, the second part of that question. Are the current technologies being demonstrated sufficient to answer all the technical questions about full-scale operations of CCS for all types of coal plants using all types of coal?

Mr. FRIEDMANN. We would say the overwhelming majority of questions on the overwhelming majority of plants.

Mr. GINGREY. Mr. Klara, did you want to comment on that?

Mr. KLARA. Yes, I would like to comment that relative to our portfolio of technologies that one size doesn't fit all. Sorry about that. Better? Relative to our portfolio that one size doesn't fit all. So a portfolio of technology is sometimes needed to get the widest deployment. And also too it is important, I think, in a portfolio to have multiple technologies essentially competing with one another.

And so what that does is it tends to really be a forcing factor to drive the cost down substantially relative to these competing options.

Mr. GINGREY. Let me go back to Dr. Friedmann. According to DOE's December 2010 CCS R&D and demonstration roadmap, there were seven CCS demonstration projects for coal power plants. Three of these plants were estimated to start up in 2014, three 2015, and one in 2016. To date, only one project, Kemper County, Mississippi gasification project operated by the Southern Company, the great Southern Company headquartered in Atlanta, Georgia, is expected to start operations this year roughly on schedule. Two of the projects have been cancelled, and the remaining four projects are 2, 3, and 4 years behind schedule according to project summaries reviewed by our committee staff.

First do you agree that some of these projects are significantly behind schedule? And secondly is it possible that we will see further delays or even abandonments before getting to the point of pushing the switch to start up operations given that four of the five projects are still only on paper? Construction has not commenced, and finance hasn't all been closed.

Mr. FRIEDMANN. Thank you. That is an excellent question, and I am happy to answer it. It is the nature of large projects that they take longer than expected, cost more than expected, and some of them don't make it. In this context, it is part of the reason why we are so committed to the portfolio of projects that we have.

Sometimes things just get in the way, and you can't anticipate them. In that exact context, we are passionately committed to seeing all of those projects succeed, all eight of them. And right now, we are on a trajectory where all eight of those projects are headed for commercialization. And I want to just reiterate, I do not believe and I would not say that I am concerned about the delays. It is the nature of large projects, in particular getting the debt financing and the equity.

Mr. GINGREY. Let me ask Mr. Klara to comment on that too as well, Dr. Friedmann.

Mr. KLARA. On the same topic?

Mr. GINGREY. Yes, on the same topic, yes.

Mr. KLARA. Yes, it is a difficult environment right now relative to putting new plants in play, and that difficult environment has a couple factors to it. One is that it requires billions of dollars worth of financing to put a plant into play and financing is——

Mr. GINGREY. OK, I am going to stop you because I have one last question that I want to get in and I don't want to run over time. Now, if that is the case, how has the Department of Energy been adjusting its timeframes and game plan to ensure that CCS technologies for coal-fired power plants are sufficiently demonstrated across the types of coal and various types of coal plants? Will you have all the answers by 2025, 2030? And what happens if two or three of these coal projects are significantly stalled or indeed cancelled?

Mr. FRIEDMANN. Again we are still on track for what we think is the second generation of demonstrations by 2025, and that that is the timeframe in which the most important learnings will be needed. Even if one or two of the projects should unfortunately

happen to fall apart, that would leave a gap in our understanding but would still provide a lot of information and a lot of technical findings around what is necessary to get projects off the ground and the likely performance of the technologies.

Mr. GINGREY. My time has expired.

Mr. MURPHY. Thank you. The gentleman's time has expired. Now recognize Mr. Tonko for 5 minutes.

Mr. TONKO. Thank you, Mr. Chair. House Republicans have talked incessantly about the administration's supposed war on coal. This simply doesn't square with reality. The fact is the Obama administration has invested billions of dollars in projects with industry partners to advance technologies for coal-fired power generation.

DOE's CCS investments along with the EPA's proposed carbon emission rules for electric plants will assure that coal has a way to remain viable even as we have to cut carbon pollution and avoid catastrophic climate change. That being said, Dr. Friedmann, how do you react to the allegations that the administration is waging this war on coal? You work with the coal industry on a regular basis. What is your relationship with the industry like?

Mr. FRIEDMANN. It is both my pleasure and my privilege to work with the coal industry, which contains some of the best minds and the best businesses in the United States. And I continue to believe that coal is actually a required part of a vibrant American economy and part of the future. In this context, the work we are doing on CCS is critical. It is a key pathway forward for a sustainable low-carbon energy future with an era of abundance of fossil energy that we live in today.

Mr. TONKO. Thank you. And, Dr. Friedmann, how important do you think DOE's CCS investments are for the future of the coal industry?

Mr. FRIEDMANN. Again it is very hard to achieve climate change goals and deep emissions reductions in the fossil energy sector without CCS. Secretary Abraham in 2002 called it basically a cine qua non technology. It is a technology which we simply need to have.

Mr. TONKO. And DOE invested some $270 million, I believe, in the Kemper facility.

Mr. FRIEDMANN. $270 million, sir.

Mr. TONKO. Right.

Mr. FRIEDMANN. Yes.

Mr. TONKO. In the Kemper facility that is set to come online later this year. How much private capital was added to that DOE initial investment?

Mr. FRIEDMANN. I believe at this point, it is up about $4.5 billion total.

Mr. TONKO. Four point five billion?

Mr. FRIEDMANN. Yes, sir.

Mr. TONKO. Well, that is an immense investment to new coal spurred by DOE funds. And according to Southern Company subsidiary, Mississippi Power, the project is creating nearly 12,000 direct and indirect construction jobs and will create over 1,000 direct and indirect permanent jobs.

Dr. Friedmann, DOE has also invested $450 million in this Summit Texas Clean Energy Project. How much private financing was added to DOE's investment in that given project?

Mr. FRIEDMANN. OK, we have committed to Kemper—I am sorry—to Summit, it is a commitment. It has not yet been spent. But it is close to financial closing. It has not yet closed financially. It is our expectation that we will ultimately lever about $3 billion of foreign direct investment into that project.

Mr. TONKO. And again according to the company, my information is that the project is expected to create up to 2,000 direct construction jobs and 150 direct permanent jobs. So what do you think these projects tell us about the future of CCS? Are private financiers going to invest billions in projects like this if they don't see them as viable or profitable?

Mr. FRIEDMANN. Again a critical finding for the Department of Energy's work in all energy sectors is that we cannot attract investment in the first plant absent government support. Once the first plant is built and demonstrated and improvements are made in engineering, business model and financing, then the second project and the third project can get done by the private sector. Absent that initial federal investment, the project won't get built.

Mr. TONKO. We are focusing on CCS today, but there are other ways to reduce carbon emissions through increasing the efficiency of coal-fired generation. And Representative Waxman, I believe, asked you a bit about that efficiency. What level of efficiency improvements are being targeted by your research program?

Mr. FRIEDMANN. We are basically looking to make for the most part incremental improvements in the efficiency. For people who aren't engineers, a one or two percent plant efficiency sounds small, but it is not. It is actually a big improvement on the output of the plant. Just a couple of basis points actually is big. For individual components of the program, for example sensors and control systems, advanced manufacturing, these sorts of things, for the most part can improve the existing fleet each a couple of percent.

Mr. TONKO. I know that I have used up my 5 minutes. So with that, I will yield back, Mr. Chair.

Mr. MURPHY. Thank you. Just to clarify what you said, you said $270 million, is that what your——

Mr. FRIEDMANN. For the Southern Company Project, yes.

Mr. MURPHY. Energy. And I think there was also some investment tax credits, $130 million or so.

Mr. FRIEDMANN. So the $130 million of investment tax credits are set to lapse in May because of the delays associated with the project.

Mr. MURPHY. So they will not get that investment tax credit?

Mr. FRIEDMANN. We are still in discussions with the IRS, but at this point, no, they would not be eligible to receive those investment tax credits.

Mr. MURPHY. And just can you follow up. So the initial costs, I think, were $1 billion now. It is $4.5 to $5 billion talking about the plant costing?

Mr. FRIEDMANN. I think the original plant costs were more like $2 billion, but yes, there has been substantial increases in the cost of the plant.

Mr. MURPHY. Thank you. Thank you for clarifying that. Now I recognize Mr. Scalise for 5 minutes.

Mr. SCALISE. Thank you, Mr. Chairman. I appreciate you holding this hearing, and I want to thank our two guests for coming from the department. The 2010 report on interagency task force on carbon capture and storage. I believe that was both Department of Energy and EPA that put that report together. But it notes that existent CO_2 capture technologies for coal-based power plants "are not ready for widespread implementation primarily because they have not been demonstrated at the scale necessary to establish confidence for power plant application." And the DOE goal of developing systems that result in a less than 10 percent increase in the cost of energy by 2015 is still at a conceptual stage.

So we had Kemper here before our committee talking about some of the challenges that they are facing in kind of being that first company to come out and do this. I think you all recognize that, you know, we still don't have a replicable model. It seems like there is a difference between Department of Energy and EPA on whether or not you have got one plant being built, how their experience is working, especially with the uniqueness of their location to energy sites where, if you can use that carbon capture to do enhanced oil recovery, which is definitely something that is important to our state in Louisiana, Texas, other states.

But if you don't have that same proximity, then the viability isn't the same either, and do you all recognize that especially when you are looking at whether this facility is a replicable facility?

Mr. FRIEDMANN. So because it has been brought up twice, let me mention that Mr. Klara was an important contributor to the 2010 report. I would be remiss if he didn't have a chance to at least speak to it. But to the pursuant of your question, the technical availability is independent of the economic viability. And we in fact have—you can deploy the same technology in Illinois where there is not enhanced oil recovery opportunities as you would deploy in Texas.

The return on investment would vary, and part of the goal is to find ways and pathways that we can pursue to reduce the cost so much that the local increase in cost of electricity is as low as possible.

Mr. SCALISE. And I will let Mr. Klara give his answer first, and then I want to get into that, that increased cost of electricity because at the end of the day, consumers are concerned as people are out advancing new technologies, we all promote the advancement of new technologies. But you have also got to be concerned about the impact on consumers when they talk about whether or not it is going to increase their household electricity rates. That is their main concern, and clearly we are seeing increases in a number of these areas on the amount people pay for their household electricity. That affects lower income people most, and yet that is one piece of the equation that I am not sure if EPA is really that concerned about right now. But, Mr. Klara, if you want to go.

Mr. KLARA. The purpose of our demonstrations is indeed to get us over that hurdle of proving the technologies in a commercial scale, and you mentioned the cost issue. These projects are first of

a kind, and, as Dr. Friedmann indicated, that is why the government investment is so important to get them up over that hurdle.

And what we can speak of relative to cost, again going back to some earlier comments, would be the fact that our portfolio is designed to drive that cost down substantially in addition to these learning curves which these demonstrations are critical to get started.

Mr. SCALISE. Let me ask you. We know that at present none of the CCS technologies for coal-fired plant power generation has successfully completed demonstration. Is that correct?

Mr. FRIEDMANN. In this country, that is correct.

Mr. SCALISE. OK, we know that this will take upwards of 10 years to establish. Is that correct?

Mr. FRIEDMANN. I don't think that is correct actually.

Mr. SCALISE. How long do you think it would be?

Mr. FRIEDMANN. Again we are already gathering learnings from our demonstrations as they are standing up. Kemper will be operational at the end of this year. That will be an important technical finding, and within sort of 2 or 3 years of operation, we should have a strong sense as to whether or not that plant is replicable in a viable option for the future.

Mr. SCALISE. Well, and I hope you would know that Southern Company, the owner of the Kemper plant, has said that this plant "cannot be consistently replicated on a national level." Were you aware that they said that?

Mr. FRIEDMANN. Yes, sir. We have had those conversations with the CEO and the senior staff of Kemper and of Southern Company. That is exactly the basis on which we have a wide portfolio of plans.

Mr. SCALISE. Because they are the ones that are out there making this big investment. They are seeing that the costs are a lot more than anybody expected, and they are also recognizing the geographical limitations that you can't just—and if EPA wants to go and say OK, look, they were able to do it and they figured out a way to make it work, cost them a whole lot more than they were expecting, but they made it work, discounting the fact that the way they had to make it work was having this close proximity for EOR. Then they are going to go and say OK, well now everybody can do it and come up with some rules that literally shut down power plants or raise the cost so high that again you get to this problem that consumers then would have 10 percent, 20 percent, maybe higher increases in their electricity rates.

And I just hope that that would be a big part of the consideration too is the impact on consumers, especially poor people, when they are going to have to pay the bill.

Mr. FRIEDMANN. Thank you again for that question. We really do understand the issues that consumers and the power generators share about concern about cost.

Mr. SCALISE. I just hope EPA has that same concern, and I yield back the balance of my time.

Mr. MURPHY. Gentleman yields back, and now to the gentleman from Mississippi who represents the third district, the home of Kemper plant, which we hope he invites this committee to. Mr. Harper is recognized for 5 minutes.

Mr. HARPER. Thank you very much, Mr. Chairman. I appreciate the opportunity, and certainly we are enjoying watching that massive facility being built in Kemper County, and as you know that is in my district in Mississippi. But it is clear others around the world are watching to see how this goes forward. If, as EPA says, this has all been done before, what is it about Kemper that makes it so important to the future of clean coal technology in this country and around the world?

Mr. FRIEDMANN. Let me start by stating that there is just an immense body of evidence around the function, cost, likely future cost, and technology pathways, current performance and so forth for carbon capture and storage. That said, we have a special place in our hearts for the Kemper plant. In part because it is truly demonstrating a novel gasification technology, the TRIG gasifier at commercial scale, in part because it is testing a new business model, this co-location of mining, upgrading, and refining.

Kemper is not just a power plant. It is basically a carbon refinery which sets out a number of products including ammonia, naphthenes, liquid fuels, as well as CO_2 for enhanced oil recovery. That business model is every bit as important as the technical findings that we are going to get from this.

Mr. HARPER. Mr. Klara, anything you would like to add to those remarks?

Mr. KLARA. Well, I concur with that, but also just a couple comments on our demonstration program in general. My belief would be that none of these project developers, none of these companies came into this with their view of this is going to be a one-off, one-of-a-kind. And so a lot of business models certainly going into our demonstration program are indeed looking at replication of this technology at some point.

Mr. HARPER. And that replication you would view as just in the United States or worldwide?

Mr. KLARA. Well, if you look back to the history of things like criteria pollutants, NOx and SOx control that the United States showed technology leadership. And much of that technology is being deployed internationally. I would expect the same to occur with the development of carbon capture and storage.

Mr. HARPER. And then Mr. Friedmann.

Mr. FRIEDMANN. If I could add a little bit to that.

Mr. HARPER. Yes, please.

Mr. FRIEDMANN. Our conversations with Southern make clear that they very much see a Kemper 2.0 and a Kemper 3.0 and imagine some of those plants around the world where low-cost lignite is also available.

Mr. HARPER. OK, and as you said the Kemper project works in this particular situation in Mississippi because of the TRIG technology, which gasifies local lignite coal and uses the carbon to increase nearby oil production. Where else in the world is there this sort of potential where you have a generation source no one would otherwise use and the CO_2 can be used for oil production?

Mr. FRIEDMANN. In the United States, we are looking all along the Gulf Coast, also in North Dakota in the lignite belt. Outside the United States, we are looking at Turkey. We are looking at inner Mongolia. We are looking at Kazakhstan. There are other

places where there are a combination of resources in the form of lignite and enhanced oil recovery opportunities. Pakistan is another one where one could imagine building a plant like this and reaping the commercial benefits.

Mr. HARPER. You know, a few years ago, people were saying that there is nowhere near the capacity in enhanced oil recovery to take the output of the CO_2 from a large part of the coal fleet. Now I am hearing some say that the capacity for EOR is growing substantially. But what is the potential for enhanced oil recovery in this country? And is there potential for this technology to grow particularly in light of recent advances in oil exploration and production?

Mr. FRIEDMANN. Thank you. That is an excellent question. It also gives me the opportunity to acknowledge the outstanding work of Advanced Resources International here in Virginia, which has done a lot of this analysis. Indeed detailed characterization and assessments of fields in the United States and worldwide shows a much higher opportunity for enhanced oil recovery than previously recognized in the United States, well north of 60 billion barrels of potential additional recovery. Beyond that, we are seeing advanced technology and practice in enhanced oil recovery, in particular, looking at residual oil zone production as a further multiplier, possibly two to three times that much in the United States, creating the opportunity for hundreds of billions of barrels around the world. In all those locations, the primary limiting step is the availability of carbon dioxide for EOR.

Mr. HARPER. Thank you both for being here, and, Mr. Chairman, I yield back the balance of my time.

Mr. MURPHY. Gentleman yields back. Now go to Mr. Olson of Texas for 5 minutes.

Mr. OLSON. I thank the chair, and welcome to Dr. Friedmann and Mr. Klara. Back home in Texas, we have a saying you probably have heard: "Always put the horse before the cart." The research you all are doing with CCS is the horse that makes CCS viable in the free market. You are pulling the cart. Unfortunately EPA is using the research as a model for the entire country that CCS is viable. That is putting the cart before the horse. It is not viable.

And, Dr. Friedmann, you testified with Ms. Schakowsky that your job is not to determine viability, just the science of it. I am glad to hear that. As she brought up, there are pockets of viability here in America for CCS. They are in Texas in my district outside of Houston. They are viable by using captured CO_2 for enhanced oil recovery operations, EOR. EPA knows this.

In the new plant rules' impact analysis, here is a quote from EPA's report. "The opportunity to sell the captured CO_2 for EOR, rather than paying directly for its long-term storage, strongly improves the overall economics."

I was pleased to hear you mention Petra Nova. That is the Parish power plant in Needville, Texas. I can see that power plant walking out on my front lawn. It is one of the largest ones in the country, as you know. Four natural gas generators of power, four coal generators of power with the natural gas, the fifth one, coming online quickly.

The plant sits on top of an old oil field, very close to it. They are planning to capture CO_2 to use it to get oil, but their situation is

unique, and that is why it may be viable. There is another project in my district called Denbury Resources there in Alvin, Texas. In 2001, they bought the Jackson Dome in Mississippi. As my colleague to my left, Mr. Harper knows, that is the largest natural CO_2 deposit east of the Mississippi River. It is 98 percent pure CO_2.

With a massive pipeline infrastructure between their fires on the Gulf Coast, going up to New England, the eastern part of the United States, they have access to pipelines. They are shipping that CO_2 from Mississippi down to Texas, the old Hastings Oil Field, and using that CO_2 to get enhanced oil recovery operations.

My question is, is it fair to say there are few situations like Parish and Denbury. Now, most states have little opportunity, no chance for enhanced oil recovery operations inside their borders.

Mr. FRIEDMANN. Thank you. I am happy to answer that question having spent happily 5 years living in Texas myself, I am sure you are familiar with the saying you don't want to be all hat, no cattle.

Mr. OLSON. Yes, sir.

Mr. FRIEDMANN. And we view our job in that context. CCS, in particular enhanced oil recovery, we view as the bridge to the bridge of the future. That if we are building a bridge through CCS deployment to a clean energy future, then EOR is an important bridge to that bridge. There are a couple of important benefits that come from EOR early deployment.

The first of these is that you actually get to build the plant. That is the critical increment that leads to reduced costs widely. In order for us to see a viable future for CCS widely deployed, we believe that the cost must come down broadly. That means building plants and demonstrating how and learning how to reduce those costs. The EOR projects give us those first-of-a-kind opportunities to figure out how to do that.

The second thing I would add is that there may be more of those opportunities than initially recognized. Per my last comments to Mr. Harper, it is looking like these residual oil zones are more broadly distributed than originally understood, and that provides more opportunity nationwide.

We are also seeing projects like the Boundary Dam Project in Canada, which is a post-combustion capture project like Petra Nova's project where they are taking CO_2 by pipeline to the Midale Field in Saskatchewan. And they have also learned enough from doing that first project that they are preparing to commit to a second project to do the same thing. Where those EOR opportunities exist, we believe it is critical to anchor early projects to reduce the total cost to the taxpayer, to increase the viability of the projects and to harvest the key learnings that we need to see CCS widely deployed.

Mr. OLSON. Yes, so it sounds like they are rare. You have to have some sort of confluence with power generation with some sort of structure near the power generation to get the CO_2 to use for enhanced oil recovery operations. I am out of my time. I just want to invite you back to Texas. You know, you will have your term up in DOE next 4 years probably. Come back to The Woodlands. You know, ExxonMobil, your former company, has built a big research

center up there. The one from Fairfax, Virginia is moving to Texas. So come on back. I yield back.

Mr. MURPHY. The gentleman yields back. Now recognize Mr. Griffith from Virginia for 5 minutes.

Mr. GRIFFITH. Thank you very much, Mr. Chairman. I do appreciate it. I have in my all-of-the-above policy, I have the four Ds, dig, drill, deregulate, and discover. Today's hearing obviously deals with discover. I do appreciate the work that you all are doing in trying to find ways that we can discover ways that we can continue to use coal because I come from a coal mining region in central Appalachia.

That being said, I have been very excited about the work that has been done by Dr. Fan at Ohio State University in regard to chemical looping, and as I understand it, last time I talked to him, he hadn't yet gotten the keys to the facility in Wilsonville, Alabama, but he was expecting to get that soon.

My question is, because I see that is so exciting because we end up with, I guess, whatever remnants are left over what is a very pure burning process of the coal ash and carbon dioxide. So we eliminate most of the cost of the capture. So let us assume for the sake of argument that it is successful, and we get to September and the experiment has worked as well as all of us could hope. What is next? Where do we go? And what does DOE do? And I appreciate NETL has been involved in this project and I appreciate that.

But what do you all do next to try to encourage industry to go to an even larger project and actually build a plant that would use this technology that doesn't have to be near lignite alone or any particular type of coal but could be used anywhere in the United States or the world.

Mr. FRIEDMANN. Again, thank you for that question, and again because Mr. Klara's organization does so much of that, I will make sure he has time to answer in part. Chemical looping technology is an example of what we would call a second generation technology in these different buckets. The work that is going on in Ohio is very exciting. We have another chemical looping project as well with Austin in Connecticut. And in fact, we are in discussions right now with ARPA–E to take over that project and to see if we can't set it up at Wilsonville and give it a run.

There are a series of technical challenges that come with association of scale-up demonstration and so forth. But I do want to mention that one of the interesting values of chemical looping is that it is actually a dual technology. It can be used on coal feed as well as on natural gas.

Mr. KLARA. And I would just like to add that we are doing everything we can to push that technology forward.

Mr. GRIFFITH. Well, and I guess my question is that assuming that it goes well, do you all think you are ready to step in and say OK, we will help fund this at some plant because we really need some help in the coal fields? And I see this as the light at the end of the tunnel. I don't see how it can possibly be done in less than 7 years, and that is with the government using the money that it has to take this discovery and make it real for people where we

don't raise the cost of electricity to where people can't afford it and we continue to use the rich coal resources of central Appalachia.

Mr. KLARA. I began this job just 3 months ago, and in that context, we are considering exactly what pieces we need to build into our research portfolio. One thing that we have begun to realize is that we need second generation large pilot projects as the critical, technical undergirding of those next generation of large demonstrations. We are trying to put together the technical considerations and specifications in partnership with NETL to figure out what that will look like in terms of technical work, milestones, and costs so that we can bring forward those proposals in future budgets.

Mr. GRIFFITH. I appreciate that. I am concerned that we do have the cart before the horse, and I appreciate what you all are doing moving forward. But I do think that some of the regulations coming out of your sister agency, not you all, but out of your sister agency, are making it hard for people to survive in the coal industry when we see technology coming down the pike that may very well solve the problems that a lot of times we hear of people bringing up in regard to the use of coal.

I would have to say in September of 2012 testimony before the Energy and Power Subcommittee, a representative from Austin who you mentioned earlier, a maker of CCS-related technology, said that it is unaware that any supplier of CCS technology is ready or able to offer commercial guarantees for full-scale systems of carbon capture. What does a technology supplier need to know to warrant and be ensured for its CCS technologies for use in a coal power plant?

Mr. FRIEDMANN. Thank you. Since that time, a number of those companies have actually do now offer performance guarantees. In part, that is because we have run these large scale pilots that they need to validate their technology. And more importantly they have had installation in some of these large-scale demonstrations. That helps provide the confidence along with other technology tools like advanced simulation to allow them to put a performance guarantee in a wrapper around those facilities.

Mr. GRIFFITH. All right, I appreciate that. Thank you very much. I yield back the remainder of my time, Mr. Chairman.

Mr. MURPHY. Mr. Johnson, you are now recognized for 5 minutes.

Mr. JOHNSON. Thank you, Mr. Chairman and gentlemen, thank you for being here with us today. I represent a part of our nation in eastern and southeastern Ohio that is very dependent upon the coal industry, both for the energy that we use and also for the livelihood for the people that work in the industry. So let me ask you a quick yes-or-no question to get started off right away. Do both of you believe that America can solve the technological concerns that the environmentalists have so that we can use and continue to use coal environmentally soundly? Just a quick——

Mr. FRIEDMANN. Unquestionably yes.

Mr. KLARA. Absolutely.

Mr. JOHNSON. And do you believe that coal and the vast resources of coal that we have should comprise a significant part of our energy portfolio moving forward?

Mr. FRIEDMANN. Yes, I do.

Mr. KLARA. Yes.

Mr. JOHNSON. OK, well thank you. Then let me get into some specific questions. In December 2010, the DOE and NETL issued a CCS research development and demonstration roadmap. Among the goals of that roadmap was that the DOE would develop technologies that can separate capture, transport, and store CO_2 using either direct or indirect systems that result in a less than 10 percent increase in the cost of energy by 2015. When does DOE and NETL anticipate demonstrating CCS systems that result in less than 10 percent increase in the cost of energy compared with the non-CCS coal-powered plants?

Mr. FRIEDMANN. Thank you again for that question. The issues of cost is just forward in our minds, and we are doing everything we can to reduce it. In that context, we again see sort of a 2025 timeline for this second generation of technologies to lead to 10 or 15 or 20 percent cost of electricity increases that are retail cost.

Mr. JOHNSON. OK, Mr. Klara, any comments?

Mr. KLARA. Correct, and I just say that relative to our technology portfolio, that those technologies are in our transformational bucket of technologies. And yes, the 2025 to 2030 timeframe is the current pathway.

Mr. JOHNSON. OK, your technology assessment published about a year ago suggests the three technologies which include sorbents and pre-combustion membranes that may help achieve the goal are only at the concept stage. Would you say that your plans of December 2010 are still on target?

Mr. FRIEDMANN. Yes, absolutely. In fact, we have seen great progress on a number of those which at the time were sort of leading technologies, things like advanced membranes, everything from oxygen separation membranes to CO_2 separation membranes. The money that we have invested has allowed those to go from sort of bench scale to small pilot testing and in one or two cases to large pilot testing. That is part of the pipeline and the pathway to that large scale commercialization.

Mr. JOHNSON. OK.

Mr. KLARA. Yes.

Mr. JOHNSON. Same thing? Over the past several years, the president's budget request for coal R&D funding has steadily declined from a request in fiscal year 2010 for $404 million to the most recent request in fiscal year 2014 for $277 million. Congress did not agree with these levels of funding and recently passed an omnibus appropriations bill increasing the funding by more than $100 million. So what does this say about your department's aggressive planning and the administration's priorities to advance coal technology if you are cutting funding for this work?

Mr. FRIEDMANN. Thank you again for that question. We recognize that the budget process is complicated, that there are many, many competing interests, and so we make our requests. And we make our recommendations to the secretary, and the secretary brings those to OMB and to the White House. And together they figure out what is in fact what they want to put into an omnibus budget.

I would say that in general I think about these kinds of questions as a tradeoff with urgency. The more urgency one has, the more one is willing to spend on any particular issue.

Mr. JOHNSON. I understand the budget process, and I realize there are conflicting priorities. But do you agree with the additional funding levels that Congress has appropriated?

Mr. FRIEDMANN. What I would say is that we have very clear ideas about how we would use that well.

Mr. JOHNSON. Good, because that was my last question. And I am sorry. I got 15 seconds so let me get that one in. Would you please submit to this subcommittee how you plan to spend this additional funding?

Mr. FRIEDMANN. Yes, we will be happy to take that question for the record——

Mr. JOHNSON. OK.

Mr. FRIEDMANN [continuing]. And to have follow up with additional meetings.

Mr. JOHNSON. All right, thank you. Mr. Chairman, I yield back.

Mr. MURPHY. The gentleman yields back. I now recognize the gentlelady from North Carolina, Ms. Ellmers, for 5 minutes.

Mrs. ELLMERS. Thank you, Mr. Chairman. And thank you to our panel. Dr. Friedmann, as I understand it, without government subsidies, and I think you have already mentioned this, the CCS demonstrations for coal plants would not be going on. Is this correct?

Mr. FRIEDMANN. Yes, that is correct.

Mrs. ELLMERS. OK, can you briefly describe to me the taxpayers, how I could go home to my North Carolina taxpayers and explain to them what return they are getting for these subsidies and technology development?

Mr. FRIEDMANN. There is a handful benefits that come forward that I think are pretty clear. In the near term, we actually get advanced technology that can be used to underlie manufacturing in the United States. Another thing I would say is that we actually bring a lot of information back to the body public, scientific, technical engineering, and business information, economic information, which is used to make important investment decisions in the United States.

I would add that our enhanced oil recovery projects provide two additional benefits. One of those is with additional secure U.S. oil supply. And the third is actually with the tax revenues from that. Something that is lost by many people is that the additional tax returns on enhanced oil recovery actually pay for all of the government investment in a span of 7 to 8 years. After that, it is actually net revenue positive.

Mrs. ELLMERS. So in my understanding, and assuming that the success of the first generation technologies does take place, there really will not be wide commercial use of these things until the 2020s. Is that correct?

Mr. FRIEDMANN. For widespread commercial use, yes, that is correct.

Mrs. ELLMERS. For widespread. So is this why the DOE's fiscal year 2014 congressional budget states, and I am quoting, "in the case of electricity generation first generation CCS technology, cost

is not expected to be low enough to achieve widespread deployment in this near term"?

Mr. FRIEDMANN. Yes.

Mrs. ELLMERS. Yes, OK. So now being that that is correct, at a coal gasification facility, the cost of electricity may be increased by 40 percent? Is this with the current carbon capture and compression technology, is this——

Mr. FRIEDMANN. For the first generation technologies, yes, that is correct.

Mrs. ELLMERS. So there will be a 40 percent increase?

Mr. FRIEDMANN. Where deployed.

Mrs. ELLMERS. Where deployed. And at a pulverized coal plant, this cost of electricity increases up to 80 percent?

Mr. FRIEDMANN. Yes, that is correct.

Mrs. ELLMERS. That is correct. What size commercial development for coal plants does DOE think is possible with current CCS technology given its highest costs?

Mr. FRIEDMANN. I am sorry. One more time. I just didn't get that.

Mrs. ELLMERS. What size commercial deployment for coal plants does DOE think is possible with current CCS technology given its high cost?

Mr. FRIEDMANN. At this point, it would be niche applications. There will be a couple of places in the country, as we heard from Mr. Olson——

Mrs. ELLMERS. OK.

Mr. FRIEDMANN [continuing]. Where you have the correct confluence of opportunity, resource, and revenue.

Mrs. ELLMERS. Just and there again, and I am probably just asking you to speculate on this. But how many would you say that would be? When you say niche, are we talking about a small—like one to five?

Mr. FRIEDMANN. Maybe a few dozen.

Mrs. ELLMERS. A few—OK, so 24——

Mr. FRIEDMANN. But I would not consider that widespread.

Mrs. ELLMERS [continuing]. Across the country about.

Mr. FRIEDMANN. Just kicking around numbers, sure.

Mrs. ELLMERS. OK, that is good, and I appreciate that. Thank you very much. Mr. Chairman, I yield back the remainder of my time.

Mr. MURPHY. Thank you. Now I recognize Mr. Long for 5 minutes.

Mr. LONG. Thank you, Mr. Chairman, and thank you all for being here today and your patience so far. Mr. Klara, has the Department of Energy estimated how many billions of tons per year will need to be stored if the United States is to sequester a substantial portion of coal-based carbon dioxide?

Mr. KLARA. There are many estimates that are out there relative to what the future could be for CO_2 production.

Mr. LONG. Many estimates from the Department of Energy?

Mr. KLARA. We rely mainly on estimates from others. So for example the Intergovernmental Panel on Climate Change, the Electric Power Research Institute has looked at these.

Mr. LONG. Do you know a ballpark range on how many billions of tons they are talking about? Have you looked at any of that or not?

Mr. KLARA. Well, some of the estimates, and we could give you specifics for a record, question for the record. But some of the specifics would be looking at CCS having to handle potentially 20 percent or more of the reduction needed to get the CO_2 stabilization. And yes, that could be in the range of a billion tons or more.

Mr. LONG. Billion or multiple billions?

Mr. KLARA. I would have to go back and look.

Mr. LONG. OK, if you wouldn't mind if you could get that for my staff, I would appreciate it.

Mr. KLARA. Yes.

Mr. LONG. And, Dr. Friedmann, I would like to draw your attention to this major CCS, which is carbon capture and sequestration demonstration projects, project locations, and cost share. This is a document that you all provided to the committee, is it not, in your packet?

Mr. KLARA. Yes, sir.

Mr. LONG. OK, I heard it recently mentioned that there are several capture and storage projects that are up and running now. There has been a lot of discussion on that here today. And yet from this graphic that you all provided, almost all these projects displayed have start dates that are a few years down the road, 2017, estimated start dated 2017, 2019, 2016, 2012, 2017, 2014, and 2015 which are all, as I say, down the road. And according to a recent congressional research report on carbon capture and sequestration, the Department of Energy has spent approximately $6 billion on CCS since 2008, most of which came from the stimulus bill that was passed a few years ago. And according to the capture, transport, and inject industrial scale, quantities of CO_2 solely for the purpose of carbon sequestration. Can you clarify one final time, I guess for the committee, why we are hearing different things in the sites and if you could cite any commercial scale carbon capture and sequestration projects that are currently now up and running generating electricity.

Mr. FRIEDMANN. Right, again so to clarify, there are a number of large-scale industrial facilities operating in the United States and around the world. There are 12 large projects which the Global CCS Institute recognizes. With respect to power generation, the closest fit is the Beulah, North Dakota plant which generates synthetic natural gas. That gas goes into the pipeline and is used to generate power. It is not a power plant per se. It is the synthetic natural gas facility.

Mr. LONG. It is a synthetic natural gas facility?

Mr. FRIEDMANN. Yes, it was built actually in the early 80s when there was an expectation that we would have decreased production of natural gas in the country and we needed to generate synthetic natural gas. That plant is——

Mr. LONG. They kind of missed their bet there, didn't they?

Mr. FRIEDMANN. One of the reasons why we do everything we do is that the future is opaque, and it is important to prepare as many options for the market as possible.

Mr. LONG. That is why I think that the private sector should be involved in more of this than the government, but I will stick with you, Dr. Friedmann. Does the Department of Energy intend to intervene to make sitting pipelines for distant carbon injection a more realistic option? I understand this has been a barrier to some utilities who want to pursue CCS projects.

Mr. FRIEDMANN. What I can say is that we have—so for any project that we have been involved in, we have supported the development and deployment of those pipelines. Where we see opportunities for regional networks to emerge that would help anchor CCS industries and large coal projects, we are keenly committed to seeing those pipelines come forward. One example of this is actually the support we have given to the FutureGen project in the FutureGen Alliance and their efforts to build a pipeline within Illinois.

Mr. LONG. OK, and, Mr. Chairman, I yield back and thank you all again for my time.

Mr. FRIEDMANN. Mr. Chairman, if I can clarify something for the record.

Mr. MURPHY. Yes.

Mr. FRIEDMANN. Thank you. This actually had to do with respect to Representative Ellmers' questions. She was asking about the price of capture. The answers which I gave were for a high fraction of capture, basically 90 or 95 percent capture. At small fractions of capture, say 50 percent capture, the actual integrated cost is much less. And that is relevant with respect to how you can deploy either modular units or smaller fractions of capture on the new or existing fleets.

Mr. MURPHY. Is that a reference to a question about the 40 percent increase in costs?

Mr. FRIEDMANN. Yes, exactly.

Mr. MURPHY. Do you have the information, or can you provide it for this committee in addition to her question about what this breaks down to in a cost-per-megawatt generation and what this would then cost the average family? Do you have that information now, or is that something you can get to us?

Mr. FRIEDMANN. We prefer to bring that to you as a question for the record and give it back to the committee later. We have made many of those kinds of calculations. Again it is the excellent work of National Energy Technology and their assessment team have done that for a wide range of power plants, a wide range of technologies, and a wide range of fuel prices. We are happy to provide that to the committee.

Mr. MURPHY. That would help the committee and the families who are trying to pay attention to this and see what this means.

Mr. FRIEDMANN. Of course.

Mr. MURPHY. I now recognize Mr. Gardner for 5 minutes.

Mr. GARDNER. Thank you, Mr. Chairman, and I thank the witnesses for joining us today. Mr. Klara, is it correct that successful development and deployment of second generation technologies are aware the Department of Energy expects the cost savings that may help make CCS for coal power competitive in the marketplace?

Mr. KLARA. I mentioned earlier, but we have three buckets of technologies that we are going after. First generation, which is the

technologies deployed now. Second generation is what you are referencing, and then we have transformational technologies. And with second generation technologies, we are headed toward a reduction in cost as indicated by your remark.

Mr. GARDNER. And what is NETL's assessment of the readiness of the technologies most critical to driving down costs?

Mr. KLARA. Certainly when it comes to carbon capture and storage, capture is by far the key element to drive the cost down, and that is the majority of the focus of our research program.

Mr. GARDNER. Have any of these second generation technologies have been taken to the demonstration phase to validate they work at commercial scale in a coal-fired power plant?

Mr. KLARA. Not at this time, second——

Mr. GARDNER. Not at this time?

Mr. KLARA. Yes, so demonstration of those would be part of your planning.

Mr. GARDNER. Dr. Friedmann, about how much of DOE's $7.6 billion over the past decade has been dedicated towards the second generation technologies?

Mr. FRIEDMANN. The overwhelming majority of the $7.6 billion that we have dedicated so far is actually to the large-scale commercial demonstrations. So, but in that context, to generate and develop the second demonstration technologies, as you said, we have put already several hundred millions of dollars into that research effort.

Mr. GARDNER. OK, and the information that I have says that we spent around $3 billion towards the second generation technologies. Would that be correct, of the $7.6 billion?

Mr. FRIEDMANN. No, I don't think that is correct actually.

Mr. GARDNER. OK, maybe we can get——

Mr. FRIEDMANN. We would be happy to clarify that. Yes, sir.

Mr. GARDNER. When do you expect demonstrations of these second generation technologies will be completed?

Mr. FRIEDMANN. The question is actually how quickly can we pilot them first. That is the critical lynchpin. Once they have been piloted at, say, that 20- to 50-megawatt scale, then the next step is commercial demonstration.

Mr. GARDNER. OK, and how long until pilot?

Mr. FRIEDMANN. One of those technologies is in fact being piloted now. For most of them, it is a question of how quickly can we put together the project.

Mr. GARDNER. OK, and so major scale, that is 20 to 50—what did you say 20 to 50?

Mr. FRIEDMANN. We are looking for—the soonest that we could get a second generation pilot up would be in 2015/2016 kind of timeline for solicitation, maybe 2018 demonstration, and then large-scale demonstrations of those technologies between 2018 and 2025.

Mr. GARDNER. OK, and do you or Mr. Klara have an estimate for when those technologies will be available commercially, warrantable, insurable, fundable on the open market?

Mr. FRIEDMANN. For the second generation technologies, again, you need to have the large-scale pilots before they can get to a warranty stage.

Mr. GARDNER. And you said around 2022 would be about when they get to demonstration?

Mr. FRIEDMANN. You might be able to do things sooner than that. I would point actually to an existing program we have under our cross-cutting budget line which is the carbon capture simulation initiative in which we are trying to use advanced super-computing technology to accelerate the sureness by which companies can provide those kinds of performance guarantees.

Mr. GARDNER. So would it be safe to say that we are looking at, based on current cost estimates, commercially warrantable, insurable, and fundable on the open market, we are looking at around 2030 or so, maybe beyond that?

Mr. FRIEDMANN. Sooner than that, but 2020 to 2025 timeframe, yes.

Mr. GARDNER. OK, can you describe in lay terms what the scale of cost savings will be expected for the so-called second generation technologies?

Mr. FRIEDMANN. To a first cut, we expect the cost to cut in half. We expect them to come in at something like $40 to $60 a ton for an integrated system.

Mr. GARDNER. And you are also working what you call transformational technologies. What would be the cost savings of these expected transformational technologies?

Mr. FRIEDMANN. Again, on a thermodynamic and an engineering basis, they can get maybe another $10, another $15 a ton cheaper. So something on the order of $30 a ton is probably about the limit of what you can reasonably expect.

Mr. GARDNER. And so when do you expect the demonstrations of those transformation technologies to be completed?

Mr. FRIEDMANN. Again we have laid out our road map, and we are hoping to see those deployed in the field by 2025.

Mr. GARDNER. OK, deployed in the field commercially?

Mr. FRIEDMANN. Yes.

Mr. GARDNER. OK, at what price of CO_2 capture per ton or percentage of capture will the cost be low enough to put a system on a level playing field economically with traditional coal-fueled electrical power production?

Mr. FRIEDMANN. I honestly don't understand your question.

Mr. GARDNER. So basically at what, the price point, the break point of CO_2 capture per ton or percentage of capture will the cost be low enough? Basically when will this be economic, low enough to put a system on a level playing field economically with traditional coal-fueled electrical power production?

Mr. FRIEDMANN. It is my contention that the second generation technologies are going to be the clean energy choice in terms of a competitive market in a variety of markets. In some markets, they won't be. In some markets, they will be. And the transformational technology would just increase the market share at that time.

Mr. GARDNER. But in terms of the cost, putting it on a level playing field from where we are today with costs from where you want to be with these new technologies cost. Do you have estimates? Have you produced estimates and that will produce estimates of when this break point will be?

Mr. FRIEDMANN. Again all environmental technologies add cost. So it is not appropriate nor do we for the purpose of policy decision compare the cost of carbon capture and storage with an unretrofitted plant or with a new build plant without it. We do that to demonstrate the delta, but a clean plant is not comparable to a Dickensian plant. They are different things.

Mr. GARDNER. OK, if you could supply any cost estimates that you have made, comparisons to the committee, that would be fantastic. And have any of your estimates changed in light of current market conditions?

Mr. FRIEDMANN. First of all, we are happy to provide those numbers. The market conditions are constantly changing. We actually try to bring that uncertainty into the way that we make our price calculations in terms of availability for labor, availability for materials, global markets for things, and so forth. In that context, as the market has changed, our estimates don't change as much as you might guess. Some of that information is baked into the way we do the calculations.

Mr. GARDNER. Thank you. And thank you, Mr. Chairman, for being generous of time.

Mr. MURPHY. Thank you, and although we are done, I am going to recognize Ms. Schakowsky for a quick clarifying question, comment, and then I will have a final clarifying question.

Ms. SCHAKOWSKY. Thank you, Mr. Chairman. First, I want to say, Dr. Friedmann, you are one of the best witnesses that I have heard before this committee, and your answers are informative and concise and I think very fair. And I appreciate that. I hope I speak for the rest of the committee. When we talk about the cost of CCS and you estimate that, I just wanted to clarify, you aren't considering that at some point there may be a cost for carbon emissions. I know that the major oil companies have already built into their business plans that there may at some point in the not-too-distant future be some sort of perhaps a carbon tax, some sort of cost. So when you estimate the cost of this technology and applying it primarily we are talking about to coal today, you aren't taking into consideration any kind of cost for the pollution that these plants produce, are you?

Mr. FRIEDMANN. Let me take just a minute to answer that if I may.

Ms. SCHAKOWSKY. OK.

Mr. FRIEDMANN. Again, thank you for the question and for your compliment. It was very nice of you to say so. Shell Oil Company has announced that they use a $50-a-ton estimate for carbon dioxide for any project that they put together. Other companies, most Fortune 500 companies have a similar kind of number which they keep in terms of how they assess risk in a carbon-constrained future.

We do not actually use those numbers to estimate cost of capture. Those are straight-up technical calculations based on the facility, the technology, the rank of coal, et cetera. What we do is we think about deployment in the context of those costs. Cost of carbon is something which is actually outside of what the Department of Energy does, but we do believe that we are in a carbon-constrained

world and that increasingly the cost of carbon dioxide emissions will be internalized into the cost of doing business.

As that happens, it is our privilege and our pleasure and my passion to find ways to drop the cost so that that deployment of clean energy technology can be as widely successful as possible to create the brightest possible clean energy future for the United States.

Ms. SCHAKOWSKY. Perfect ending as far as I am concerned. Thank you.

Mr. MURPHY. Thank you, and I have a clarifying question here too. So you mentioned about Kemper. They have that advantage of being able to use enhanced oil recovery from their plant. Different coal plants around the nation may not have that same advantage. And as you were preparing information for us, would you let us know what you believe the costs are for new plants or retrofitting old plants?

Mr. FRIEDMANN. Yes.

Mr. MURPHY. Give us some comparisons and having that public because we would like the companies themselves to be able to respond to those estimates if you would be able to get that for us.

Mr. FRIEDMANN. Yes, we would be happy to.

Mr. MURPHY. Thank you.

Mr. FRIEDMANN. Let me add that the availability of EOR doesn't affect the cost of the project. It affects the revenue, and so that of course affects the economics. But we try to keep the revenues and the benefits and the costs in separate categories for exactly that kind of comparison.

Mr. MURPHY. Thank you. And also for the sake of the American people, to help us translate that into what is going to be the cost for homeowners in order to make these kind of transitions as well as for businesses so we all share a concern that energy cost increasing means the impact upon manufacturing. We see that affecting some countries in the EU as well.

So thank you, and I echo the comments of Ms. Schakowsky. Dr. Friedmann and Mr. Klara, you have been very informative. We appreciate just giving us the facts. That was very helpful and will help us move forward. So I want to thank both the witnesses that participated in today's hearing and remind members they have 10 business days to submit questions for the record, and I ask you to respond to questions promptly. And we will leave it at that. So with that again I thank the panel, and this hearing is adjourned.

[Whereupon, at 12:03 p.m., the Subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

PREPARED STATEMENT OF HON. FRED UPTON

This hearing continues the committee's ongoing oversight of the Department of Energy, and the status of its work to develop technologies that will help advance cleaner and more efficient electricity production from coal-based power generation.

For several decades, Congress has entrusted DOE through appropriations and legislative direction to help advance the technologies that will dramatically improve how we use our abundant coal resources to the benefit of the American economy. With its vast scientific, technical, and engineering capabilities, DOE continues to have great potential for helping to promote cleaner, less expensive electricity production.

DOE also plays a central role coordinating the nation's energy policy and is most directly responsible for ensuring America has a secure, affordable, diverse, and reliable energy supply.

So our oversight of DOE should help illuminate two issues.

One involves the agency's stewardship of the taxpayer funding Congress has provided the agency to pursue clean coal technologies. In addition to nearly $3.5 billion in Recovery Act funding, the agency has been provided an average of $350-$400 million dollars annually over the past decade to pursue important answers about carbon capture and sequestration technologies for coal-based electricity generation.

According to DOE's program plans, the purpose of this research is to develop workable and less expensive CCS technologies, and to introduce new efficiencies that will benefit any type of coal generation systems. But DOE's own plans expect this will take decades to prove. We have a responsibility on this committee to ensure the groundbreaking work we entrust DOE to pursue is on track and not sidetracked by rushed decision-making or shortsighted policy initiatives that threaten meaningful technological progress.

Secondly, we also must work to spotlight how DOE is performing its role in the nation's energy policy making. Over the past five years, we have witnessed an onslaught of EPA rules and proposals that have significantly affected or threaten to affect the nation's ability to provide a diverse and abundant supply of electricity. At the same time, assumptions about the relative economic potential of various sources of energy have shifted over the past decade, with the newfound abundance of natural gas. This is raising new challenges and opportunities for an abundant energy future.

It is not yet clear whether DOE is really in the driver's seat or taking a backseat to EPA on the policy or the technology matters that may have a direct impact on our national energy policy. So as we conduct our oversight, we should be mindful of and think about whether, in fact, DOE is truly up to the task, given existing authorities, for guiding policy and providing the research to support a secure energy future.

# # #

PREPARED STATEMENT OF HON. G.K. BUTTERFIELD

Each year the science of climate change is reinforced. How much more proof is needed for my Republican colleagues to accept reality and acknowledge that humans contribute to climate change?

The number and intensity of severe weather instances are increasing according to NOAA. Science continues to point out the human impact on severe weather. My constituents in eastern North Carolina were hard hit by Hurricanes Irene and Sandy. A 15 year old girl in Goldsboro and a man taken in his home by a felled tree were amongst several North Carolinians who lost their lives.

I would be remiss if I failed to mention the third largest coal spill in our nation's history which occurred in Eden, North Carolina on February 2nd. The spill jeopardizes the drinking water of North Carolinians and the ecosystem of the Dan River and Lake Gaston. We must keep in mind the impacts on those in close proximity to power plants and their coal ash ponds, many of which are in low-income communities and communities of color.

The President's Climate Action Plan will help our nation reduce our contribution to climate change. It is a decisive step toward creating new energy jobs and being innovative instead of remaining complacent. I look forward to working with all stakeholders to find sensible and affordable ways to reduce climate change.

THE COMMITTEE ON ENERGY AND COMMERCE

MEMORANDUM

February 7, 2014

TO: Members, Subcommittee on Oversight and Investigations

FROM: Committee Majority Staff

RE: Hearing on "Department of Energy Oversight: Status of Clean Coal Programs"

On Tuesday, February 11, 2014, at 10:00 a.m. in 2123 Rayburn House Office Building, the Subcommittee on Oversight and Investigations will hold a hearing entitled "Department of Energy Oversight: Status of Clean Coal Programs." The hearing will review the status of the Department of Energy's clean coal programs. In particular, the Committee will examine the research, development, demonstrations, and timeframes to support the advancement of carbon capture and sequestration technologies for potential future commercial deployment at coal-based power plants.

I. WITNESSES

S. Julio Friedmann, Ph.D
Deputy Assistant Secretary for Clean Coal
U.S. Department of Energy

Scott Klara
Acting Director
National Energy Technology Laboratory
U.S. Department of Energy

II. BACKGROUND

The Department of Energy (DOE) plays a key role in seeking to accelerate the commercial availability of technologies to reduce carbon dioxide (CO_2) emissions from coal power plants. DOE's Office of Fossil Energy oversees research on these technologies through its coal research, development, and demonstration (RD&D) program. The program is implemented through DOE's National Energy Technology Laboratory (NETL), which conducts basic R&D and manages cost-sharing and collaborative work with universities, private entities, and demonstration projects.

With regard to coal power generation, carbon capture and sequestration (or storage), also known as CCS, involves the separation of carbon dioxide from coal-based power plant flue gas

or syngas and either using it – in enhanced oil recovery (EOR) for example – or storing it before it can be released into the atmosphere.

Deployment of CCS includes four primary steps: CO_2 capture, compression, transport, and storage. According to DOE, the three general categories of CO_2 capture that can be applied to coal-based power plants are pre-combustion, post-combustion, and oxy-combustion. Pre-combustion capture is applicable to integrated gasification combined cycle (IGCC) power plants, while post- and oxy-combustion capture can be applied to conventional pulverized-coal (PC) power plants. In the predominant approach to CCS, the captured CO_2 is transported via pipeline to a permanent storage site or used for enhanced oil recovery. CO_2 may be stored permanently underground in geologic formations, such as depleted oil and gas fields, un-mineable coal seams, and saline formations.[1]

Commercially available so-called first-generation CO_2 capture technologies are used in various industrial applications. However, according to NETL, these technologies are not ready in their current state of development for implementation on commercial coal-based power plants because they have not been demonstrated at appropriate scale, require approximately one-third of the plant's steam and power to operate, and are cost prohibitive.[2] The *2010 Report on the Interagency Task Force on Carbon Capture and Storage* notes that existing CO_2 capture technologies for coal-based power plants "are not ready for widespread implementation primarily because they have not been demonstrated at the scale necessary to establish confidence for power plant application."[3]

To answer the technical questions and develop confidence in the commercial application of CCS, DOE has supported the development and evaluation necessary to demonstrate effective integration of first generation CCS technologies at coal power plants. However, even with successful demonstration, economic barriers to commercial deployment will remain. In its 2014 Budget Request, DOE explains that "these demonstrations focus on first generation CCS technologies and seek to demonstrate that CCS can be integrated at commercial scale while maintaining reliable, predictable and safe plant operations. However, in the case of electricity generation, first generation CCS technology cost is not expected to be low enough to achieve widespread deployment in the near term."[4]

From FY 2005 through FY 2014, DOE has been appropriated more than $7.6 billion to support advancement of CCS technologies for eventual commercialization.[5] Of this amount, about $4.45 billion has been allotted to demonstrate first generation CCS technologies, through the Clean Coal Power Initiative (CCPI), and FutureGen 2.0 and the Industrial Carbon Capture and Storage (ICCS) programs.

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[1] *See* DOE/NETL Carbon Dioxide Capture and Storage RD&D Roadmap, December 2010. *For additional background, see* Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy, Congressional Research Service, September 30, 2013. R42496.

[2] See NETL at http://netl.doe.gov/research/coal/carbon-capture.

[3] *See* 2010 Report on the Interagency Task Force on Carbon Capture and Storage, August 2010, at 50.

[4] *See* Department of Energy FY 2014 Congressional Budget Request, Volume 3, April 2013, *at FE-5.*

[5] This sum includes about $4.2 billion in annual appropriations since 2005 and $3.4 billion in the 2009 American Recovery and Reinvestment Act (ARRA). DOE has been co-funding large-scale demonstrations of emerging clean coal technologies to hasten their adoption since 1985. It has been funding R&D for sequestration since about 1997.

At present, DOE is pursuing eight major demonstration projects under these three programs.[6] The demonstrations cover power generation at the five facilities associated with coal power generation, ranging from 240 megawatts (MW) power output to around 580 MW. Six of the eight projects use the captured CO_2 for enhanced oil recovery; two seek demonstrations of sequestration in saline formations. (See attachment.) Only one of the coal power facilities, the Kemper County IGCC project, is presently under construction. According to current schedules, the evaluation and reporting on "lessons learned" from the demonstrations associated with coal power – including the Kemper County facility – will be completed over the period of 2020 through around 2023.

In the meantime, DOE is pursuing and supporting research to seek advances in various integrated power and capture technologies that may achieve substantial cost reductions. Of funding appropriated since FY 2005, more than $3 billion has been committed to pursuing these second generation technologies and so-called transformational technologies, processes, and tools that will result in lower costs for CCS implemented on coal power plants.

The agency's January 2011 plan for developing and advancing second generation CCS technologies established four program goals: (1) develop technologies that can separate, capture, transport, and store CO_2 using either direct or indirect systems that result in a less than 10 percent increase in the cost of energy by 2015; (2) develop technologies that will support industries' ability to predict CO_2 storage capacity in geologic formations to within ±30 percent by 2015; (3) develop technologies to demonstrate that 99 percent of injected CO_2 remains in the injection zones by 2015; (4) complete Best Practices Manuals for sequestration site selection, characterization, site operations, and closure practices by 2020.[7]

DOE and NETL have set an "aggressive timeline" for second generation and transformational technologies moving from the laboratory to pilot testing through actual demonstration that ranges from the mid-2020s timeframe to the mid-2030s, respectively – depending on private industry funding.[8] Whether these goals will be realized, of course, has a substantial degree of uncertainty given the risks of failure inherent in technological research. DOE goals and timetables for development and demonstration appear to have slipped since 2010. For example, at present only one of the first-generation CCS demonstration projects is meeting the start-up date estimated in DOE's CCS research, development, and demonstration roadmap issued in December 2010[9] – other coal-based projects are two to four years behind schedule. The goal to develop systems that result in less than a 10 percent increase in the cost of energy by 2015, according to current assessments, appears to be still at concept stage.[10]

This past October, in light of the funding authorized, and recent regulatory proposals by EPA that assert the "adequate demonstration" and commercial viability of CCS on coal power plants, the Committee wrote DOE to examine the extent to which DOE programs have

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[6] *See* Major Demonstration Programs: Program Update 2013, DOE/FE-0565, September 2013.
[7] *See* Carbon Sequestration Program: Technology Program Plan, February 2011, at 10.
[8] *See* Clean Coal Research Program: Carbon Capture Technology Program Plan, January 2013 at *31*.
[9] *See* DOE/NETL Carbon Dioxide Capture and Storage RD&D Roadmap, December 2010.
[10] *See* 2012 Technology Readiness Assessment—Clean Coal Research Program, DOE/NETL, December 2012.

contributed to advancements with respect to research, development, and demonstration of CCS technologies. The inquiry also sought information on what DOE's work has accomplished in terms of reducing the cost and related deployment barriers for carbon capture and storage technologies.[11] This hearing will continue to inform this inquiry.

III. ISSUES

The following issues may be examined at the hearing:

- What is the status and timeline of major demonstration projects?
- What is the status and timeline of second generation and transformational CCS technologies?
- What technical and economic barriers must be overcome to advance future commercial deployment of clean coal technologies and CCS?
- What challenges confront cost-effective deployment of CO_2 storage and sequestration programs?

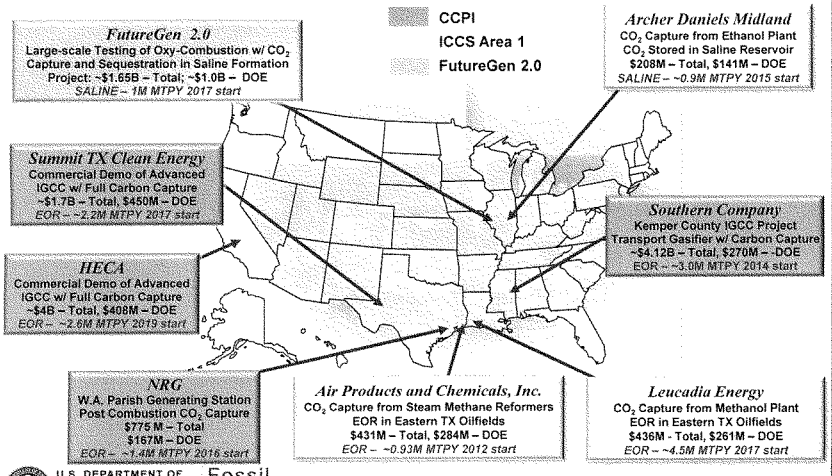
IV. STAFF CONTACTS

If you have any questions regarding this hearing, please contact Peter Spencer or Sam Spector of the Committee staff at (202) 225-2927.

[11] See Committee Web site.

Major CCS Demonstration Projects

Project Locations & Cost Share



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Congress of the United States
House of Representatives
COMMITTEE ON ENERGY AND COMMERCE
2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6115
Majority (202) 225-2927
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March 10, 2014

Dr. Julio Friedmann
Deputy Assistant Secretary for Clean Coal
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Dr. Friedmann:

Thank you for appearing before the Subcommittee on Oversight and Investigations on Tuesday, February 11, 2014, to testify at the hearing entitled "Department of Energy Oversight: Status of Clean Coal Programs."

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for ten business days to permit Members to submit additional questions for the record, which are attached. The format of your responses to these questions should be as follows: (1) the name of the Member whose question you are addressing, (2) the complete text of the question you are addressing in bold, and (3) your answer to that question in plain text.

Also attached are Member requests made during the hearing. The format of your responses to these requests should follow the same format as your responses to the additional questions for the record.

To facilitate the printing of the hearing record, please respond to these questions and requests with a transmittal letter by the close of business on Monday, March 24, 2014. Your responses should be mailed to Brittany Havens, Legislative Clerk, Committee on Energy and Commerce, 2125 Rayburn House Office Building, Washington, D.C. 20515 and e-mailed in Word format to brittany.havens@mail.house.gov.

Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,

Tim Murphy
Chairman
Subcommittee on Oversight and Investigations

cc: Diana DeGette, Ranking Member, Subcommittee on Oversight and Investigations

Attachments

Department of Energy
Washington, DC 20585

May 14, 2014

The Honorable Tim Murphy
Chairman
Subcommittee on Oversight and Investigations
Committee on Energy and Commerce
U. S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

On February 11, 2014, Dr. S. Julio Friedmann, Deputy Assistant Secretary for Clean Coal, Office of Fossil Energy, testified regarding "Department of Energy Oversight: Status of Clean Coal Programs."

Enclosed are the answers to seven questions submitted by you for the hearing record.

Also enclosed are six Inserts that were requested by Representatives Cory Gardner, Bill Johnson, Billy Long, and you to complete the hearing record.

If we can be of further assistance, please have your staff contact our Congressional Hearing Coordinator, Lillian Owen, at (202) 586-2031.

Sincerely,

Christopher E. Davis
Principal Deputy Assistant Secretary
for Congressional Affairs
Congressional and Intergovernmental Affairs

Enclosures

cc: The Honorable Diana DeGette, Ranking Member

QUESTIONS FROM REPRESENTATIVE TIM MURPHY

Q1. At a September 20, 2012 hearing before the Energy and Commerce Committee's Energy and Power Subcommittee, a representative for Alstom, a maker of Carbon Capture and Storage (CCS) related technology, testified that "it is unaware that any supplier of [CCS technology] is ready or able to offer commercial guarantees for…full scale systems of carbon capture." The representative testified that "the final stage to reach commercial status is to perform a demonstration at full commercial scale…It is critical to be at commercial scale to define the risk of offering the technology. This cannot be defined until the technology can be shown to work at full scale. This is the first opportunity that we have to work with the exact equipment in the exact operating conditions that will become the subject of contractual conditions when the technology is declared commercial and is offered under standard commercial terms including performance and other contractual guarantees," In your response on February 11, 2014 to a question by Rep. Griffith about those commercial guarantees, you stated that, since the Alstom testimony, "a number of those companies have actually, do now offer performance guarantees." Are the performance guarantees you reference in your testimony the same as the manufacturer's commercial guarantees described in the September 2012 testimony?

   a. If so, have these guaranteed technologies been demonstrated in CCS systems in operating electric generating units at full commercial scale, sufficient to define the risks in the exact operating conditions that will become the subject of contractual conditions when the equipment is offered under standard commercial terms?

A1a. Although some CCS suppliers have stated their willingness to provide performance guarantees, the extent of the terms, conditions of those guarantees and the enforceability are not known at this time. The guarantees typically cover such things as the amount of CO_2 captured per day, the purity of the product, and the energy consumption required by the process. If one of the guaranteed performance specifications is not met, the supplier typically has to rectify the problem and/or pay liquidated damages. For guarantees provided to current CCS demonstration projects, it is likely the extent of the damage payments is significantly less than what would be expected for a more widely deployed technology. DOE has successfully demonstrated for the past year, a CCS project on a commercial scale. For example, the Air Products CCS demonstration project – funded in

part by the Department – has been capturing CO2 since May 10, 2013. DOE also has other projects that are near completion and will become operational soon thereafter.

b. Identify the specific technologies and specific companies offering performance guarantees that support your testimony, and whether the manufacturers will warrant these technologies for use in utility-scale commercial service on coal-based electric power plants.

A1b. There are three companies that have provided performance guarantees for utility-scale CCS projects. More detail can be provided in a manner that allows for the safeguarding of confidential business information. However, we can state that we have successfully demonstrated for the past year, a CCS project on a commercial scale utilizing CO_2 Capture from Steam Methane Reformers.

Q2. In response to a question to confirm that CCS has not being implemented commercially at full scale on a functioning electric power plant, you disagreed and provided the example of the Beulah, North Dakota Gasification Facility, claiming this industrial facility was a power plant because it supplied natural gas that may be used in power plants.

a. Does the Beulah facility represent successful demonstration of CCS systems on a commercial, coal-based electric generating unit that is supplying electric power to the electric grid?

A2a. The Great Plains Synfuels Plant is a commercial-scale coal gasification plant that manufactures natural gas. Synthetic natural gas (SNG) is a gaseous fuel manufactured from coal using the coal gasification process. SNG produced at the Great Plains Synfuels Plant leaves the plant through a two-foot in diameter pipeline that transports the gas 34 miles to a gas portal on the Northern Border Pipeline.

The Great Plains Synfuels Plant also produces a variety of coproducts including about 50 billion standard cubic feet of carbon dioxide annually. Since 2000, more than 25 million

tons of CO2 has been captured, compressed and transported through a 205 mile pipeline to oil fields near Weyburn, Saskatchewan, Canada for use in enhanced oil recovery.

b. What is the history of DOE's loan guarantee in support of the plant? What was the taxpayer liability, in 2014 dollars, after the partners defaulted on the DOE loan?

A2b. In the early 1980's, the Department of Energy (Department) guaranteed a $1.5 billion loan for the construction of a facility for converting coal into synthetic natural gas near Beulah, North Dakota. In 1985 the partnership which developed the Great Plains Coal Gasification Plant (Plant) experienced financial difficulties and defaulted on their $1.5 billion loan. The amount of $1.55 billion dollars of loan guarantee default in 1985 would convert to $3.37 billion in 2014 dollars (Calculated using the Bureau of Labor Statistics CPI data.) The Department repaid the lender and operated the facility from 1985 through 1988.

In October 1988, the Department sold the Plant to the Dakota Gasification Company (a subsidiary of Basin Electric Power Cooperative) for 1) $85 million, 2) a share of future revenues which ultimately totaled more than $390 million, and 3) secured a waiver of tax credits valued at about $750 million.

Q3. In your testimony, you mentioned an $8 billion loan guarantee solicitation, which was released on December 13, 2013 and covers a broad range of advanced fossil energy projects.

a. The loan guarantees under this new solicitation are authorized by Title XVII of the Energy Policy Act of 2005 and will be administered by DOE's Loan Programs Office, correct?
b. Advanced fossil energy projects include technologies such as carbon capture, correct? What kinds of projects do you plan to support under this program?
c. How will they be similar to and/or differ from the existing major demonstration projects in CCS.

A3a,b,&c. The Advanced Fossil Energy Projects solicitation is authorized by Title XVII of the Energy

Policy Act of 2005 through Section 1703 of the Loan Guarantee Program and is administered by the Department's Loan Programs Office (LPO).

Under the Title XVII program, these loan guarantees are made available to support projects that employ new or significantly improved technology, are located in the United States, reduce, avoid, or sequester greenhouse gases, and have a reasonable prospect of repayment of both principal and interest. For more information, please reference the solicitation materials on the Loan Programs Office website: http://lpo.energy.gov/resource-library/solicitations/advanced-fossil-energy-projects-solicitation/

Q4. DOE indicated that it expected the initial applications under this new loan guarantee program by the end of February 2014. Did Doe receive any applications by February 28, 2014 that relate to CCS technologies for coal-based power plants?

a. If so, describe how many and the types of projects.
b. What timeframe do you anticipate for awarding these loan guarantees and for the full implementation of the underlying advanced fossil energy projects?

A4. DOE has received applications under the initial February 28, 2014 Part I application deadline.

DOE anticipates additional applications in response to the future deadlines given the time required to develop projects and complete applications.

Under this solicitation, applications will undergo a two-part review: Part I will determine the initial eligibility of a project and whether it is ready to proceed. Applications that clear Part I then proceed to Part II, which includes the full application process and continued due

diligence. Viable projects that are granted a conditional commitment from DOE then undergo the complete underwriting process and negotiation of terms for the loan guarantee.

Q5. You suggested that the Environmental Protection Agency's requirement of CCS use by the power sector would facilitate state utility commission authorization of cost recovery for CCS through consumer rates.

a. When do you expect state utility commissions to authorize consumer rate-based cost recovery for non-government-subsidized CCS meeting EPA standards?

A5a. Please note that DOE has no jurisdiction over state utility commission decision-making processes and each state utility commission is unique. We offer the following perspective in response: Many factors are considered when a state utility commission authorizes consumer rate-based cost recovery for any new power project. The cost of the technology is certainly one constraint, but other factors may be in play in specific scenarios which would encourage the use of more expensive technologies such as CCS. For instance, coal based systems provide ancillary services and reliability, and diversify the fuel mix, which may be necessary in some situations.

The timeframe for acceptance and deployment of any individual technology will depend on a number of factors in addition to cost, including but not limited to external system constraints that may provide the right market conditions earlier than expected. In addition, highly constrained areas that require base load power in the absence of strong natural gas infrastructure, the proximity to economic enhanced oil recovery opportunities and expectations about future carbon policy may make first generation technologies attractive in some early cases, without government subsidies.

b. Explain how state utility commission could authorize such consumer rate-based cost recovery for non-subsidized-CCS, given the prevalence of cheaper generation source alternatives. Upon what rationale would a state utility commission make such an authorization given competing availability of natural gas and nuclear fueled power generation?

A5b. Please note that DOE has no jurisdiction over state utility commission decision-making processes and each state utility commission is unique. We offer the following perspective in response: When a power system is chosen, its goal is to meet specific site and system requirements using a mix of available information including forecasts of future situations. Factors such as fuel diversity, system reliability, and other benefits a technology can provide are part of the consideration. The positives and negatives are weighed, with cost being only one of those factors.

State utility commissions could authorize rate recovery based on those considerations. In some instances, the electricity system has a requirement for a specific type of technology. Coal plants with CCS may diversify the fuel mix and reduce a region's dependence on a single fuel type. A plant may also provide baseload power with high capacity factors, stable, consistent fuel prices, and provide stronger reactive power and voltage control. These ancillary services may be necessary for the system, and coal with CCS could be uniquely positioned to do so. If the right mix of requirements, including future anticipated needs, can be met at an acceptable cost to the state utility commission, they may allow a non-subsidized-CCS plant.

Q6. DOE's Energy Information Administration (EIA) recently reported in its 2014 Annual Energy Outlook that, after the addition of current demonstration projects, there will be no increase in coal-based electricity generation in the United States for up to 30 years.

a. If market and regulatory factors indicate no new coal power capacity, please explain where DOE will find the facilities to demonstrate its CCS technologies for coal-based power at utility scale.

A6a. DOE typically pursues technology demonstrations utilizing a mix of projects that include the entire plant and smaller projects to integrate and demonstrate specific new technology components, also keeping in mind what is most likely to be successfully replicated on a commercial scale. Our current focus is the construction and operation of the existing portfolio of demonstration projects.

b. What are you doing, if anything, to adjust your program goal and development and demonstration plans to reflect these EIA projections?

A6b. DOE's Clean Coal Research Program will continue to focus on providing advanced technology options that produce affordable, efficient, low-carbon electricity from coal.

Q7. You stated that you hoped to see an increase in large scale deployment of CCS so it would manage 12-20% of U.S. emissions by 2050.

a. To attain such widespread deployment, how many power plants does DOE assume would implement CCS in the ensuing time period; how many over the next five years and in each five year period between now and 2050?

A7a. Through the CCPI, we are currently demonstrating the first generation set of technologies for application in new plants and retrofit to existing plants. The Office of Fossil Energy will continue to explore transformational technologies for future power systems. In the post-2020 timeframe, we may see the retirement of many base load units, which could result in the need for additional base load power plants.

The latest outlook from Annual Energy Outlook projects energy sector CO_2 emissions to be about 5,700 million metric tons in 2040. The reduction of CO_2 will come from a

variety of sources which are difficult to predict and model this early. A portion will likely come from the expansion of renewable technologies and fuel switching. We believe that industrial CCS projects can provide some of the early experience in CCS, and also encompass a large number of point sources.

Mr. {Klara.} Yeah.

Mr. {Johnson.} Same thing? Over the past several years, the president's budget request for coal R&D funding has steadily declined from a request in fiscal year 2010 for $404 million to most recent request in fiscal year 2014 for $277 million. Congress did not agree with these levels of funding and recently passed an omnibus appropriations bill increasing the funding by more than $100 million. So what does this say about your department's aggressive planning and the administration's priorities to advance coal technology if you are cutting funding for this work?

Mr. {Friedmann.} Thank you again for that question. We recognize that the budget process is complicated, that there are many, many competing interests, and so we make our requests. And we make our recommendations to the secretary, and the secretary brings those to OMB and to the White House. And together they figure out what is in fact what they want to put into an omnibus budget.

I would say that in general I think about these kinds of questions as a tradeoff with urgency. The more urgency one has, the more one is willing to spend on any particular

issue.

Mr. {Johnson.} I understand the budget process, and I realize there are conflicting priorities. But do you agree with the additional funding levels that Congress has appropriated?

Mr. {Friedmann.} What I would say is that we have very clear ideas about how we would use that well.

Mr. {Johnson.} Good, because that was my last question. And I am sorry. I got 15 seconds so let me get that one in. Would you please submit to this subcommittee how you plan to spend this additional funding?

Mr. {Friedmann.} Yeah, we will be happy to take that question for the record--

Mr. {Johnson.} Okay.

Mr. {Friedmann.} --and to have follow up with additional meetings.

Mr. {Johnson.} All right, thank you. Mr. Chairman, I yield back.

Mr. {Murphy.} The gentleman yields back. And now recognize the gentlelady from North Carolina, Ms. Ellmers, for 5 minutes.

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The Department plans to spend the additional funding for the Coal Research Program by continuing to support research and development of second generation and transformational technologies that reduce the cost of carbon capture, improve efficiency of power plant operations, and ensure safe permanent storage of carbon dioxide. Funding plans include the following:

- Carbon Capture will continue laboratory, bench, and small pilot scale tests for second generation and transformational technologies. This includes continued support for the National Carbon Capture Center, recently competed.
- Carbon Storage:
    - Will implement activities in the appropriations language for enhanced oil recovery technologies and continue the support for the large-scale injection tests of the Regional Carbon Sequestration Partnerships.
    - Has released a funding opportunity announcement for Geologic Storage Technologies to address key questions associated with CO_2 injection such as geomechanical effects and reservoir and seal behavior.
- Advanced Energy Systems:

- The Fuel Cells activity is addressing the technical challenges to commercialization, specifically cell performance, reliability and durability, and will advance and test progressively larger solid oxide fuel cell systems (~ 60 kWe) that will be the building block for commercial solid oxide fuel cell systems.
- Efforts are also being expanded in Gasification on novel polygeneration concepts that will build upon prior scoping studies.

- Crosscutting Research:
  - Will support efforts on water management by identifying key opportunities to reduce water consumption and to add new water supplies (e.g., derive revenue for waste-water treatment products and to further improve the use of alternative water streams currently being wasted).
  - Computational tools such as those being developed by the National Risk Assessment Partnership (NRAP) and the Carbon Capture and Simulation Initiative (CCSI) will also be continued. NRAP will develop Integrated Assessment Model Development with Monitoring and Mitigation for Risk-based Monitoring and Mitigation Protocols for Long-Term Carbon Storage and CCSI will support the initial deployment of the CCSI Toolset to industry users.

confluence of opportunity, resource, and revenue.

Mrs. {Ellmers.} Just and there again, and I am probably just asking you to speculate on this. But how many would you say that would be? When you say niche, are we talking about a small--like one to five?

Mr. {Friedmann.} Maybe a few dozen.

Mrs. {Ellmers.} A few--okay, so 24--

Mr. {Friedmann.} But I would not consider that widespread.

Mrs. {Ellmers.} --across the country about.

Mr. {Friedmann.} Just kicking around numbers, sure.

Mrs. {Ellmers.} Okay, that is good, and I appreciate that. Thank you very much. Mr. Chairman, I yield back the remainder of my time.

Mr. {Murphy.} Thank you. Now recognize Mr. Long for 5 minutes.

Mr. {Long.} Thank you, Mr. Chairman, and thank you all for being here today and your patience so far. Mr. Klara, has the Department of Energy estimated how many billions of tons per year will need to be stored if the United States is to sequester a substantial portion of coal-based carbon

dioxide?

Mr. {Klara.} There are many estimates that are out there relative to what the future could be for CO2 production.

Mr. {Long.} Many estimates from the Department of Energy?

Mr. {Klara.} We rely mainly on estimates from others. So for example the Intergovernmental Panel on Climate Change, the Electric Power Research Institute has looked at these.

Mr. {Long.} Do you know a ballpark range on how many billions of tons they are talking about? Have you looked at any of that or not?

Mr. {Klara.} Well, some of the estimates, and we could give you specifics for a record, question for the record. But some of the specifics would be looking at CCS having to handle potentially 20 percent or more of the reduction needed to get the CO2 stabilization. And yes, that could be in the range of, you know, a billion tons or more.

Mr. {Long.} Billion or multiple billions?

Mr. {Klara.} I would have to go back and look.

Mr. {Long.} Okay, if you wouldn't mind if you could get

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According to the U.S. Energy Information Administration's (EIA) 2014 Annual Energy Outlook, the 307-gigawatt (GW) fleet of existing U.S. coal-fueled power plants emitted 1,514 million metric tons (MT) of carbon dioxide (CO_2) while generating 1,499 billion kilowatt-hours of electricity in 2012. This corresponds to an average coal fleet CO_2 emission rate of 2,222 lbs/MWh. If CO_2 were captured from the existing fleet of coal-fueled power plants, the total CO_2 storage requirements would depend on how much of the fleet was controlled for CO_2, the capacity factor for each plant, and the percentage of CO_2 captured from each plant. A CO_2 capture rate of approximately 40% would be required to achieve a CO_2 emissions rate of 1,100 pounds per gross megawatt-hour. A 90% CO_2 capture rate is the nominal goal of the U.S. Department of Energy's Clean Coal Research Program.

Mr. {Friedmann.} One of the reasons why we do everything we do is that the future is opaque, and it is important to prepare as many options for the market as possible.

Mr. {Long.} That is why I think that the private sector should be involved in more of this than the government, but I will stick with you, Dr. Friedmann. Does the Department of Energy intend to intervene to make sitting pipelines for distant carbon injection a more realistic option? I understand this has been a barrier to some utilities who want to pursue CCS projects.

Mr. {Friedmann.} What I can say is that we have--so for any project that we have been involved in, we have supported the development and deployment of those pipelines. Where we see opportunities for regional networks to emerge that would help anchor CCS industries and large coal projects, we are keenly committed to seeing those pipelines come forward. One example of this is actually the support we have given to the FutureGen project in the FutureGen Alliance and their efforts to build a pipeline within Illinois.

Mr. {Long.} Okay, and, Mr. Chairman, I yield back and

thank you all again for my time.

Mr. {Friedmann.} Mr. Chairman, if I can clarify something for the record.

Mr. {Murphy.} Yes.

Mr. {Friedmann.} Thank you. This actually had to do with respect to Representative Ellmers' questions. She was asking about the price of capture. The answers which I gave were for a high fraction of capture, basically 90 or 95 percent capture. At small fractions of capture, say 50 percent capture, the actual integrated cost is much less. And that is relevant with respect to how you can deploy either modular units or smaller fractions of capture on the new or existing fleets.

Mr. {Murphy.} Is that a reference to a question about the 40 percent increase in costs?

Mr. {Friedmann.} Yes, exactly.

Mr. {Murphy.} Do you have the information, or can you provide it for this committee in addition to her question about what this breaks down to in a cost-per-megawatt generation and what this would then cost the average family? Do you have that information now, or is that something you

can get to us?

Mr. {Friedmann.} We prefer to bring that to you as a question for the record and give it back to the committee later. We have many of those kinds of calculations. Again it is the excellent work of National Energy Technology and their assessment team have done that for a wide range of power plants, a wide range of technologies, and a wide range of fuel prices. We are--be happy to provide that to the committee.

Mr. {Murphy.} That would help the committee and the families who are trying to pay attention to this and see what this means.

Mr. {Friedmann.} Of course.

Mr. {Murphy.} I now recognize Mr. Gardner for 5 minutes.

Mr. {Gardner.} Thank you, Mr. Chairman, and I thank the witnesses for joining us today. Mr. Klara, is it correct that successful development and deployment of second generation technologies are aware the Department of Energy expects the cost savings that may help make CCS for coal power competitive in the marketplace?

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The cost to the average family varies greatly due to regional variations in electric generation and market structure. Additionally, the type of generation technology and future status will also influence the cost. As such, it is not really possible to undertake this analysis well. DOE has not determined nor is it aware of an assessment which determines the cost for the average family of deploying carbon capture technologies under a specific greenhouse stabilization scenario.

Mr. {Klara.} I mentioned earlier, but we have three buckets of technologies that we are going after. First generation, which is the technologies deployed now. Second generation is what you are referencing, and then we have transformational technologies. And with second generation technologies, we are headed toward a reduction in cost as indicated by your remark.

Mr. {Gardner.} And what is NETL's assessment of the readiness of the technologies most critical to driving down costs?

Mr. {Klara.} Certainly when it comes to carbon capture and storage, capture is by far the key element to drive the cost down, and that is the majority of the focus of our research program.

Mr. {Gardner.} Have any of these second generation technologies have been taken to the demonstration phase to validate they work at commercial scale in a coal-fired power plant?

Mr. {Klara.} Not at this time, second--

Mr. {Gardner.} Not at this time?

Mr. {Klara.} Yeah, so demonstration of those would be

part of your planning.

Mr. {Gardner.} Dr. Friedmann, about how much of DOE's $7.6 billion over the past decade has been dedicated towards the second generation technologies?

Mr. {Friedmann.} The overwhelming majority of the $7.6 billion that we have dedicated so far is actually to the large-scale commercial demonstrations. So but in that context, to generate and develop the second demonstration technologies, as you said, we have put already several hundred millions of dollars into that research effort.

Mr. {Gardner.} Okay, and the information that I have says that we spent around $3 billion towards the second generation technologies. Would that be correct, of the $7.6 billion?

Mr. {Friedmann.} No, I don't think that is correct actually.

Mr. {Gardner.} Okay, maybe we can get--

Mr. {Friedmann.} We would be happy to clarify that. Yes, sir.

Mr. {Gardner.} When do you expect demonstrations of these second generation technologies will be completed?

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Over the past decade, the total investment in first generation CCS technologies has been $4.45 billion in first generation technologies and $3.15 billion for second generation and transformational technologies.

cut in half. We expect them to come in at something like $40 to $60 a ton for an integrated system.

Mr. {Gardner.} And you are also working what you call transformational technologies. What would be the cost savings of these expected transformational technologies?

Mr. {Friedmann.} Again on a thermodynamic and an engineering basis, they can get maybe another $10, another $15 a ton cheaper. So something on the order of $30 a ton is probably about the limit of what you can reasonably expect.

Mr. {Gardner.} And so when do you expect the demonstrations of those transformation technologies to be completed?

Mr. {Friedmann.} Again we have laid out our road map, and we are hoping to see those deployed in the field by 2025.

Mr. {Gardner.} Okay, deployed in the field commercially?

Mr. {Friedmann.} Yeah.

Mr. {Gardner.} Okay, at what price of CO2 capture per ton or percentage of capture will the cost be low enough to put a system on a level playing field economically with traditional coal-fueled electrical power production?

Mr. {Friedmann.} I honestly don't understand your question.

Mr. {Gardner.} So basically at what, the price point, the break point of CO2 capture per ton or percentage of capture will the cost be low enough? Basically when will this be economic, low enough to put a system on a level playing field economically with traditional coal-fueled electrical power production?

Mr. {Friedmann.} It is my contention that the second generation technologies are going to be the clean energy choice in terms of a competitive market in a variety of markets. In some markets, they won't be. In some markets, they will be. And the transformational technology would just increase the market share at that time.

Mr. {Gardner.} But in terms of the cost, you know, putting it on a level playing field from where we are today with costs from where you want to be with these new technologies cost. Do you have estimates? Have you produced estimates and that will produce estimates of when this break point will be?

Mr. {Friedmann.} Again all environmental technologies

add cost. So it is not appropriate nor do we for the purpose of policy decision compare the cost of carbon capture and storage with an unretrofitted plant or with a new build plant without it. We do that to demonstrate the delta, but a clean plant is not comparable to a Dickensian plant. They are different things.

Mr. {Gardner.} Okay, if you could supply any cost estimates that you have made, comparisons to the committee, that would be fantastic. And have any of your estimates changed in light of current market conditions?

Mr. {Friedmann.} First of all, we are happy to provide those numbers. The market conditions are constantly changing. We actually try to bring that uncertainty into the way that we make our price calculations in terms of availability for labor, availability for materials, global markets for things, and so forth. In that context, as the market has changed, our estimates don't change as much as you might guess. Some of that information is baked into the way we do the calculations.

Mr. {Gardner.} Thank you. And thank you, Mr. Chairman, for being generous of time.

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In the current market, capturing CO_2 from an existing coal-fueled power plant will increase its cost of generating electricity relative to a traditional coal-fueled power plant, but offsetting revenues can be obtained by selling the captured CO_2 for a beneficial use such as enhanced oil recovery. If the Clean Coal Research Program R&D goals are achieved, coal-fueled power plants which utilize second generation CO_2 capture technology are projected to be competitive with other electricity generating sources, but will be dependent upon future market conditions and status of technology development of these other fuel sources and generating technologies.

that if I may.

Ms. {Schakowsky.} Okay.

Mr. {Friedmann.} Again thank you for the question and for your compliment. It was very nice of you to say so. Shell Oil Company has announced that they use a $50-a-ton estimate for carbon dioxide for any project that they put together. Other companies, most Fortune 500 companies have a similar kind of number which they keep in terms of how they assist risk in a carbon-constrained future.

We do not actually use those numbers to estimate cost of capture. Those are straight-up technical calculations based on the facility, the technology, the rank of coal, et cetera. What we do is we think about deployment in the context of those costs. Cost of carbon is something which is actually outside of what the Department of Energy does, but we do believe that we are in a carbon-constrained world and that increasingly the cost of carbon dioxide emissions will be internalized into the cost of doing business.

As that happens, it is our privilege and our pleasure and my passion to find ways to drop the cost so that that deployment of clean energy technology can be as widely

successful as possible to create the brightest possible clean energy future for the United States.

Ms. {Schakowsky.} Perfect ending as far as I am concerned. Thank you.

Mr. {Murphy.} Thank you, and I have a clarifying question here too with it. So you mentioned about Kemper. They have that advantage of being able to use enhanced oil recovery from their plant. Different coal plants around the nation may not have that same advantage. And as you were preparing information for us, would you let us know what you believe the costs are for new plants or retrofitting old plants?

Mr. {Friedmann.} Um-hum.

Mr. {Murphy.} Give us some comparisons and having that public because we would like the companies themselves to be able to respond to those estimates if you would be able to get that for us.

Mr. {Friedmann.} Yeah, we would be happy to.

Mr. {Murphy.} Thank you.

Mr. {Friedmann.} Let me add that the availability of EOR doesn't affect the cost of the project. It affects the

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